THE TECH ENGINEERING NEWS

DECEMBER
1946

ONE MORE STRAW—ONE LESS CAMEL!

Many centuries ago the weight of one last straw broke a camel's back. Thus somebody's artless optimism about the strength of a vital part wrecked a perfectly good materials handling system.

Today it is plain, cold fact that ignoring the depressing effect of low temperatures on the impact strength of vital steel parts can be a short cut to a long line of avoidable, costly troubles.

The solution for the problem in the fable was less load or more camel. For the modern problem the answer is a molybdenum steel that combines the deep hardening and freedom from temper brittleness necessary to provide good low temperature impact strength.

MOLYBDIC OXIDE—BRIQUETTED OR CANNED • FERROMOLYBDENUM • "CALCIUM MOLYBDATE"
CLIMAX FURNISHES AUTHORITATIVE ENGINEERING DATA ON MOLYBDENUM APPLICATIONS.

Climax Molybdenum Company

500 Fifth Avenue · New York City

MOLY

Woman With a Whim of Iron

She had the determination of Tugboat Annie. and *she wanted to know!*

She wanted to know how you can tell a Budd-built car when you see one. How you can know that it's built of stainless steel from end to end, from truck to roof, inside and out—the strongest, safest car built.

Here's one way to identify a stainless steel car—the kind that is only built by Budd.

Look above the silvery fluted sides. Look above the broad panorama windows. See that curve between the side and the roof?

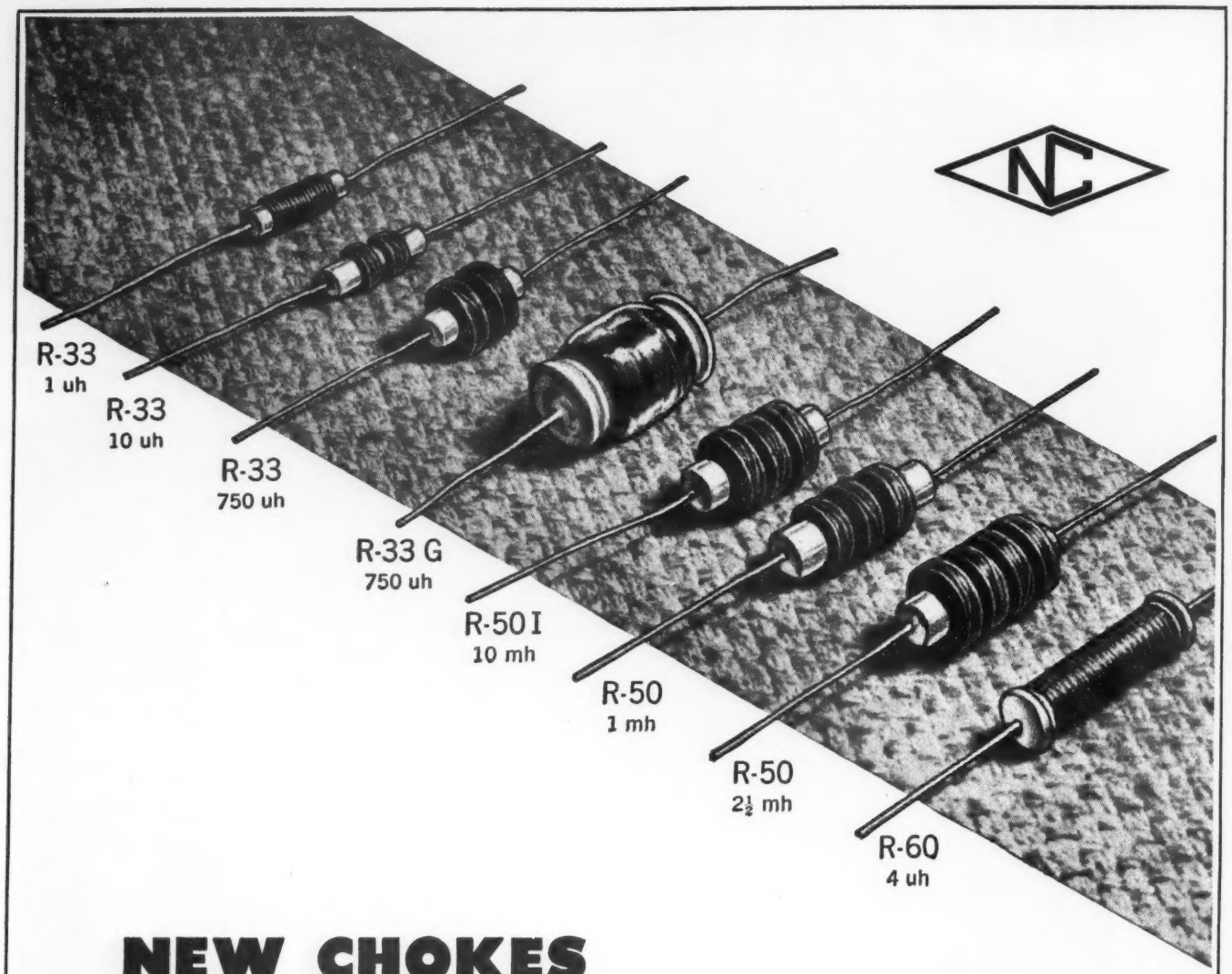
If it's smooth, the car has only a thin stainless steel icing. Just a shimmering skin. It is not a stainless steel car and Budd did *not* build it.

But if it's deeply corrugated, then the roof adds its own girder-like strength to the rest of the car's structure. And it's welded to stainless steel frames, which, in turn, are welded to a stainless steel floor, end posts and center-sill. And Budd built it.

That's one way you tell a Budd car—just look above the windows.

The Budd Company, Railway Division, Phila.

Budd



NEW CHOKES

The enlarged line of chokes now offered by National includes many new sizes and types and provides units suited to specialized as well as standard applications. Many popular new chokes are illustrated above, including the R-33G which is hermetically sealed in glass. Other models cover current ratings from 33 to 800 milliamperes in a variety of mountings carefully planned for your convenience. These as well as old favorites like the R-100 are listed in the latest National Catalogue.

NATIONAL COMPANY, INC., MALDEN, MASS.

The TECH ENGINEERING NEWS

PROFESSIONAL JOURNAL OF THE UNDERGRADUATES

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

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The cloud at approximately full growth. Note the unusual contours at various places along its height.

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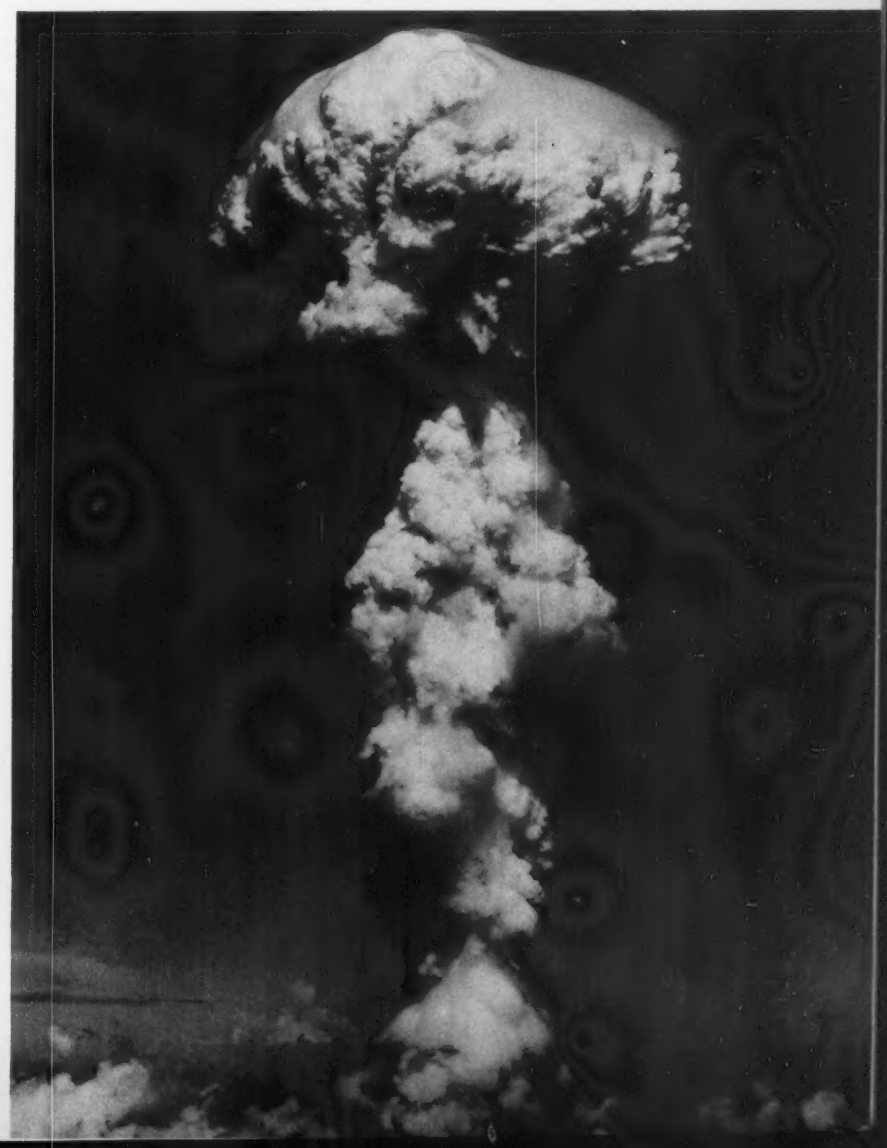
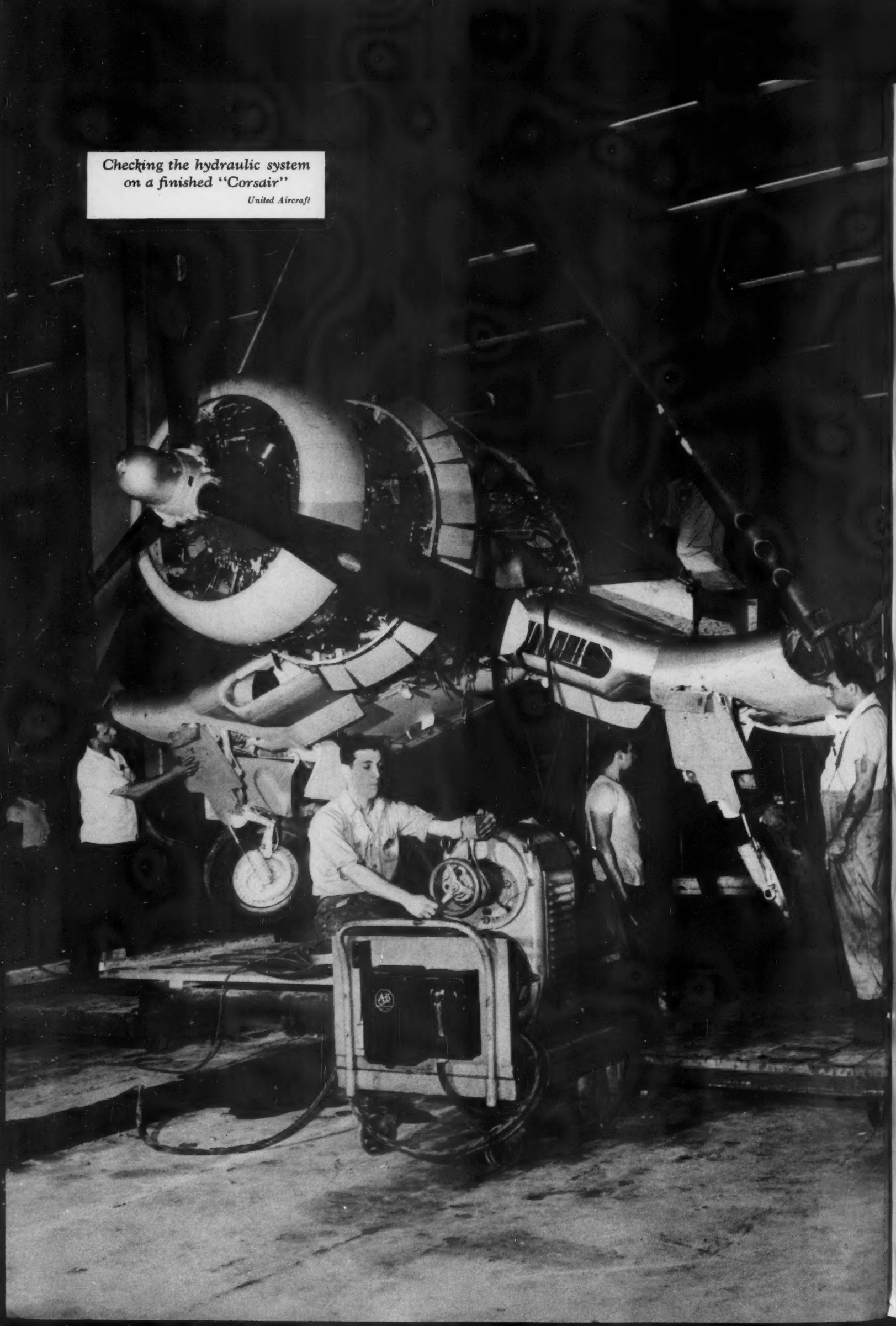




Checking the hydraulic system on a finished "Corsair"

United Aircraft

Modern Aircraft Manufacture

By FLETCHER EATON, '49

PART I

THE purpose of this article is to give the reader a brief description of the process by which a modern airplane comes into being. Many persons have a fair conception of automotive methods and problems through long familiarity at first hand with the machine and through countless published articles. With the ever-increasing importance of air transport, it is felt that a similar familiarity with aircraft methods is desirable. The author, for the purposes of this description, will draw upon his experience as a former employee of the United Aircraft Corporation; however, the basic principles of aircraft manufacture are essentially the same for all companies.

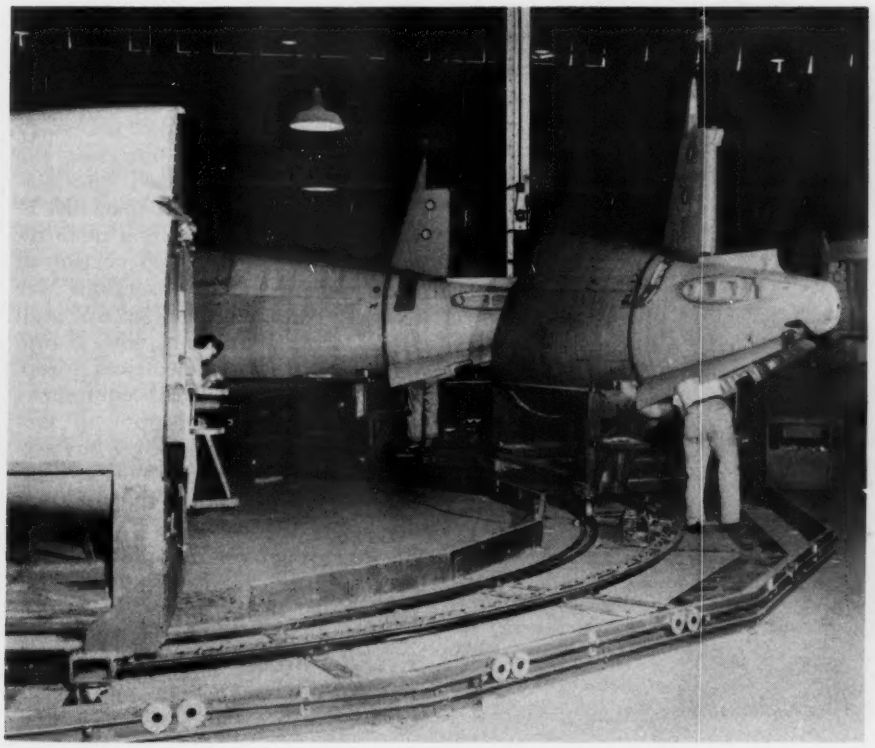
The first step in the creation of a new design is the formulation of a set of requirements which must be met or exceeded by the aircraft. Usually these requirements are provided by the customer — the United States Government, for example. They set forth in general terms what the range, speed, payload, ceiling, passenger capacity, maneuverability, etc., of the airplane must be. Armed with this information, the designer sets about the task of resolving the many difficulties created when one airplane is expected to do many different things well.

Assuming that he has brilliantly dispatched all problems and has his design clearly in mind, the engineer draws a preliminary three-view sketch. Using this sketch as a starting point and with the aid of extensive aerodynamic calculations, a much more detailed drawing is made which gives the important overall dimensions. It would be risky to proceed beyond this preliminary stage without proof that one's design was sound and would perform as expected in actual flight. An accurate scale model for wind-tunnel test is therefore built in the wood-working shop of the manufacturer. In these days of supersonic speeds, slight irregularities in surface contour create drag and vibration which are very detrimental to performance; thus, the model made for wind-tunnel testing must be exceedingly smooth and accurate if test results are to mean anything. It follows that the artisans who do the model-making must be craftsmen of the first grade. A trip through the wood-working shops of a large aircraft manufacturer would provide sufficient evidence on this point.

Another method used in the preliminary stages of airplane design, is for the designer to do his thinking through the skilled hands of a sculptor. This process has the advantage

United Aircraft

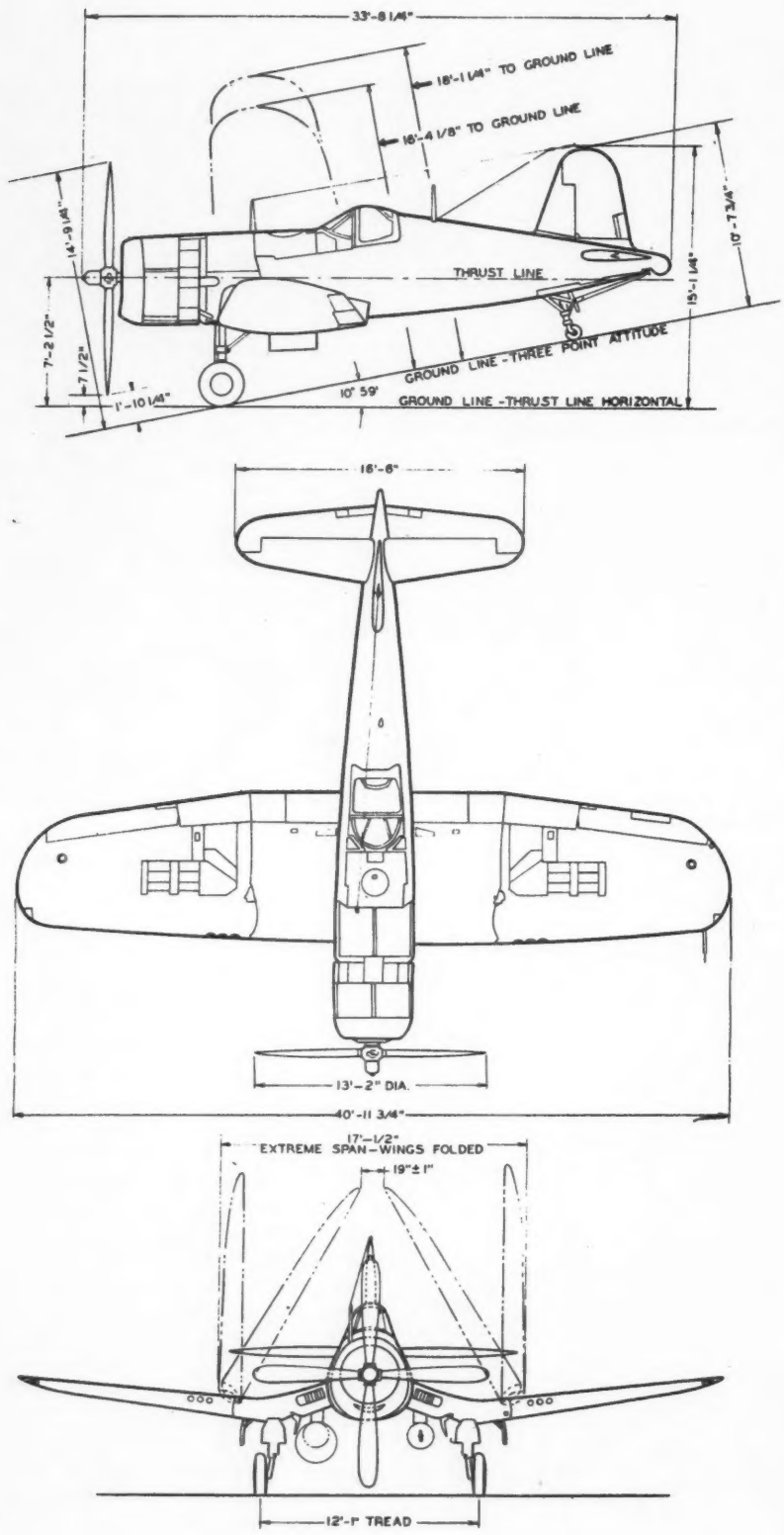
A general view of the plant. Cockpit sections in the foreground



Fuselage sections start down the production line

United Aircraft

CHANCE VOUGHT AIRCRAFT F4U-4 "CORSAIR"

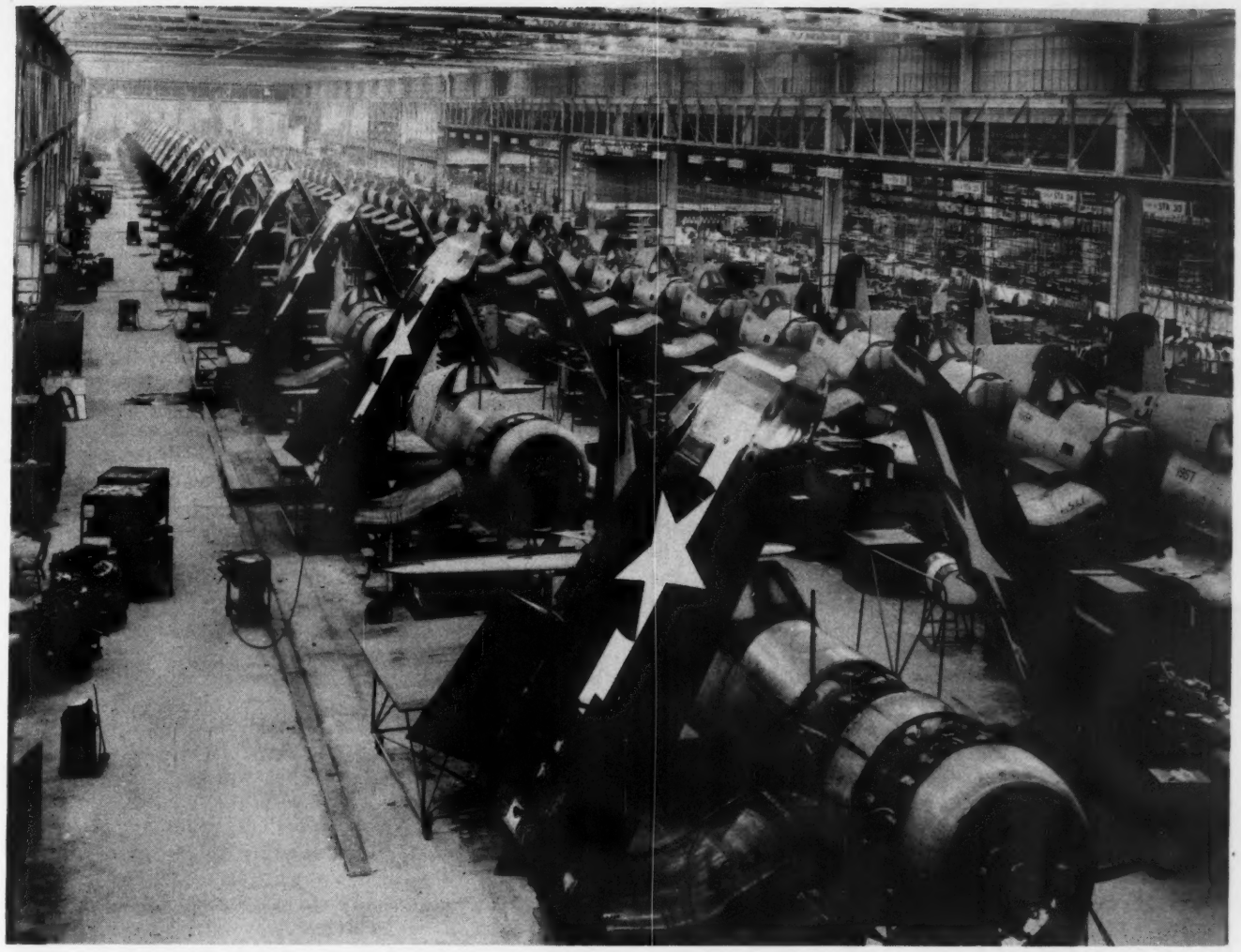


that changes in the model can be made in a minimum of time and at small expense. Once a design has been achieved that "looks" right, the sculptor makes a plaster model which can be tested immediately. Aerodynamic faults discovered during the test are corrected in the next plaster model and the process repeated until an acceptable shape is evolved. This use of the services of a sculptor has great promise, in the author's opinion, because it enables the designer to see, three-dimensionally, what he is doing. Visualization of complicated shapes is always difficult, even for those blessed with "structural imagination." Sculptored models hurdle this visual problem while saving much time formerly devoted to the making of detailed drawings.

Once the external shape of the plane is agreed upon, the next step calls for the drawing of full-sized contours rigidly defining this external shape. This basic step is done in the mold loft. Here, cross-sections through the entire plane from wing root to tip and from propeller hub to tail at intervals of every four inches are drawn on large sheets of metal with the utmost attention to accuracy. All parts of the plane must be fitted *inside* these basic lines. A separate sheet of metal is used for each cross-section through the airplane, and on it is drawn a view of all the structural components adjacent to that particular section.

Now the complex machinery of the engineering department is ready to swing into action. All preliminary calculations have been made and accurate information as to the external shape of the airplane is available. It now remains for the engineers to fill in the necessary structure. For this purpose, the drafting room is divided into sections, each headed by a specialist in his field. Each section is a team responsible for its assigned portion of the airplane. These sections are named: the fuselage group, tail group, armament group, wing group, power plant group, electrical group, controls group, special equipment group, hydraulics group — in fact a group is created whenever any section of the airplane becomes so complicated as to require the constant attention of specialists.

Presiding over the efforts of the drafting room teams are three very important departments — structures, weights, and aerodynamics. Every drawing produced by men in the drafting room must be checked by all three. The parts described



United Aircraft

Business end of the final production line in the Stratford, Connecticut, plant. F4U-4's nearing completion

must be strong enough, they must be no heavier than necessary and they must be properly located with respect to the center of lift of the plane in order that the plane remain stable in flight. Furthermore, any part exposed to the wind stream must be aerodynamically clean. When it comes to a choice between two designs, the word of any one of the three departments mentioned is law.

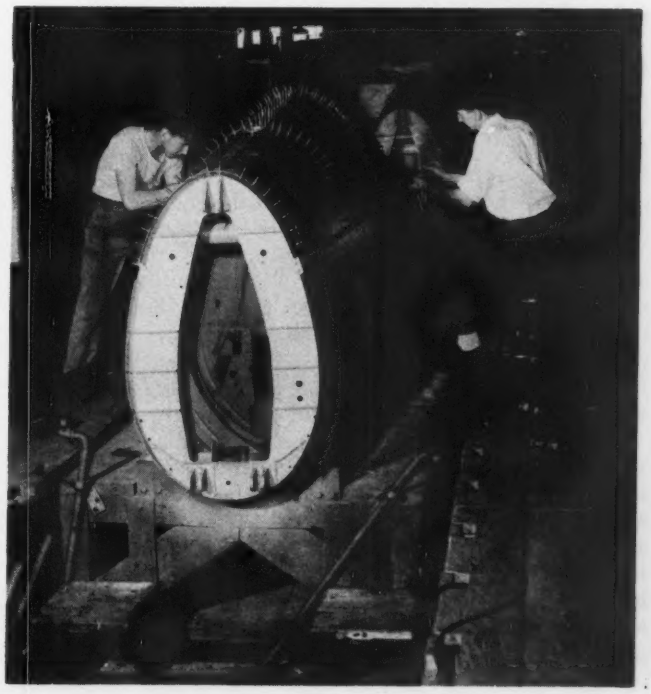
With the temporary completion of work by the engineering department, emphasis shifts to the program of tooling up for production. Modern all-metal aircraft are composed of literally thousands of parts, each of which has to be made with a separate set of production tools. Not only are sheet metal parts and other components made at the parent factory, but many parts are made by outside companies located in all parts of the country. Were it not for the performance of vendor companies, as they were called, much of the staggering war production of aircraft would never have been achieved. In the case of the Chance Vought *Corsair*, while the original plans were drawn at the Vought factory, eventual mass production was made possible by outside companies which fabricated whole sections of the plane and shipped them ready for assembly. Complete wings were shipped to the Connecticut plant by truck from the Middle West. Similarly, tail sections, landing gear, motors, propellers, and other parts were shipped to the factory for assembly.

One familiar with automotive methods of production would be struck by the similarity of certain parts of the aircraft production process. For one thing, assembly line methods are used wherever possible. An

(*Continued on page 118*)

Bristling with rivets, a body section gets its covering

United Aircraft



German Wartime Industrial Developments

By EDWARD A. MULLERY, '48

OVERSHADOWED in the public imagination by the spectacular use which has been made of the V-2 rocket bomb, captured German industrial secrets nevertheless promise to bring about great advances in American industry. Groups of American and British scientific and industrial experts moved in swiftly behind the advance into Germany and have returned with valuable information on German processes and products. Teams of American investigators have gone into all parts of the Reich and in return British, Russian, and French teams have been allowed to pursue their work in the American zone. Through the Office of the Publication Board of the Department of Commerce, the results of the investigations are now made available to American businessmen and educational institutions, and to foreign governments as well.

German scientists, faced with shortages of critical materials, developed many substitutes, some of which have proved so successful that they will probably be used in preference to the old products in some applications. Synthetic mica is an outstanding example. This consists of mixed oxides, fluorides, and silicofluorides of aluminum, magnesium, iron, chromium, and vanadium. These substances are melted together and crystallize into a product very similar to natural mica. Both the electrical resistance and the breakdown voltage of the synthetic mica are higher than for natural mica, claim the Germans. For this reason, synthetic mica was used in heavy-duty condensers where natural mica had failed. According to an American investigator, the synthetic product would cost about ten times as much as natural mica for general use; but its highly uniform quality, elasticity, and strength might actually make it less expensive for high-grade condensers, since the cost of selecting and testing for quality would be greatly reduced.

Several other substitutes for mica were developed. By impregnating glass fabric with a mixture of bakelite and kaolin in alcohol, the Germans obtained a product which could be used as an insulating material between commutator bars. For capacitor dielectrics, plastic films such as cellulose acetate were combined with ceramic powder at a temperature of 160 degrees Centigrade. Dielectrics with permittivity values in excess of 100 were produced in quantity by this process, and samples with a permittivity of 2000 were prepared, as compared with a permittivity of approximately 6 for mica. The American investigator who reported on this project suggested that the increased efficiency resulting from the use of such dielectrics might lead to the more widespread use of electrostatic generators.

The shortage of natural fats and oils during the war led to the use of synthetics in the German tanning industry. Unlike ordinary substitutes for the preparation of leather, such as mineral oil and paraffin, the synthetic materials reportedly stay in the leather when it is immersed in cold water. Many German tanners have stated that they expect to continue to use the synthetics in part even when the natural fats and oils are again available.

Besides the development of substitutes for scarce materials, the Germans also made improvements in several basic chemical processes. In the production of chlorine gas, for instance, German processes were superior to American, since less floor space was required for the production of chlorine at a given rate from the electrolysis of sodium chloride. Another advantage of the German method was the production, as a by-product, of high strength caustic soda (50–70 per cent). A caustic solution of this strength can be used directly in the production of rayon; whereas the American process for the electrolysis of sodium chloride produces a 12 per cent caustic solution, and this must be concentrated before it can be used in the viscose process.

Another German chemical process of great interest, particularly to the Army and Navy, is a method of concentrating 35 per cent solutions of hydrogen peroxide to 80 per cent or higher. Development of this process enabled the Germans to use peroxide as an efficient fuel in submarines, rockets, rocket aircraft, and torpedoes. A research team of the Chemical Engineering Department of M. I. T. is now making further investigations into the use of peroxide as a source of power.

Still another chemical problem which the Germans appear to have handled more effectively than the Allies is connected with the use of acetylene as a raw material in the synthesis of many chemical products. The chief difficulty in these processes has been the danger of explosions when using acetylene on an industrial scale. By developing techniques for the safe handling of acetylene, the Germans have been able to use it in the synthesis of acetone; "Koresin," which is used in synthetic rubber tires; and other products.

In electronics, as in the chemical industries, significant results were achieved by German scientists and engineers. At the present time, the most promising among these seems to be an ingenious German machine which may revolutionize the manufacture of paper condensers for electronic equipment. Instead of using strips of metal foil separated by paper, the new process utilizes a very thin, vaporized zinc coating, applied directly onto the paper dielectric. More than fifty million condensers of this type were produced by one German company during the war.

One great advantage of this type of condenser is that it heals automatically after a momentary overload; hence it can be operated at voltages 20 to 50 per cent higher than paper and foil capacitors. The metallized paper capacitators are also about 40 per cent smaller than the paper and foil type, and cost about 20 per cent less to produce.

In the production of vacuum tubes, the Germans found that gold plating the metal leads sealed in the glass envelopes greatly reduces losses of high-frequency current. Technicians in a German-controlled Dutch factory also improved the method of sealing the leads into the glass by fusing powder glass around the leads. This eliminated, to a great extent, the problem of matching the coefficient of expansion of the glass with that of the leads.

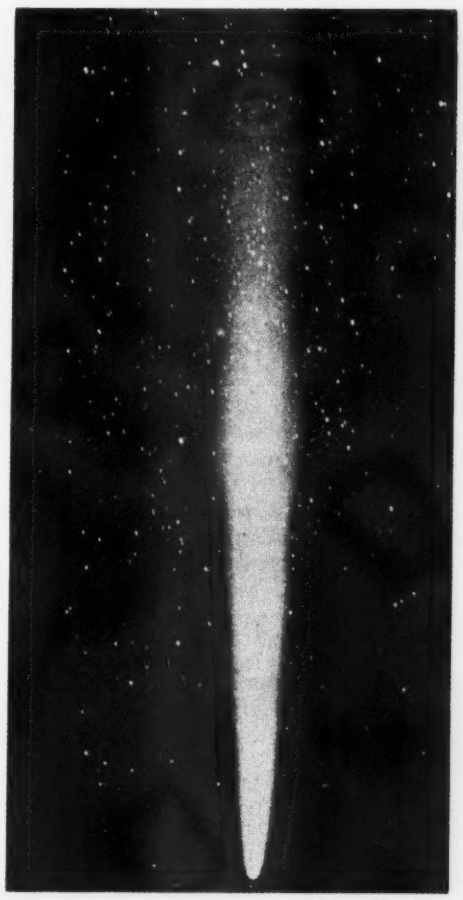
The German army's field teletypewriter, using an

(*Continued on page 132*)

THE CHRISTMAS STAR

By PETER B. NIEMAN, '48

EVER since the first man learned to worship, men have inseparably welded religion and astronomy. The earliest forms of worship were of the sun, the seasons, and the night sky. Inborn in mankind is a feeling that the gods of nature, of worship, and of revenge dwell "up" in the heavens. Although the majority of man's worship of the celestial was in the form of fear of death, or retribution for his sins, there has been a unique period of celebration set aside by almost every people since the beginnings of recorded time. This is the time of the winter solstice, when the sun stops its cold descent into the horizon, and once more climbs



Sky and Telescope

Halley's comet

toward the zenith, restoring warmth and daylight to the world. The sun-god had answered the prayers of the people, and a day of celebration was decreed by men all over the world. The date of the festival was set at December 25, the day of the rebirth of the sun.

The Nativity was first celebrated on January 6. However, this was so close to the celebration of the winter solstice, and this festival day was so deeply rooted in the world's culture, that soon the two holidays merged into one day, December 25.

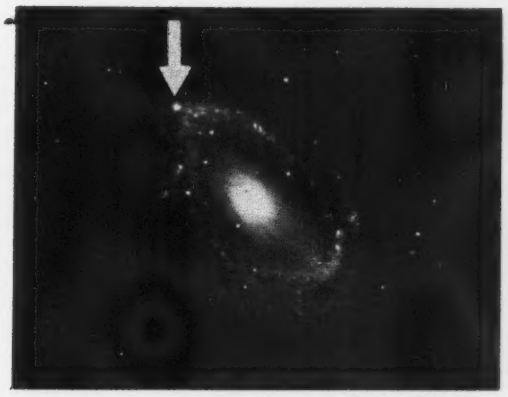
The most striking example of the welding of astronomy and religion is in the legend of the Christmas Star, which dates back to the Gospel of Saint Matthew, Chapter II. The story reads:

Now when Jesus was born in Bethlehem of Judaea, in the days of Herod the king, behold, there came wise men from the east to Jerusalem,

2. Saying: Where is he that is born King of the Jews? For we have seen his star in the east, and we are come to worship him. . . .

9. When they had heard the king, they departed, and lo, the star, which they saw in the east went before them. . . .

10. When they saw the star, they rejoiced. . . .



Sky and Telescope
Mount Wilson Observatory photo

A supernova, forty million times as bright as the sun which appeared in the spiral nebula NGC 4725 in 1940

For a long time, men have tried to decide just what was the Christmas Star. The only description of it that was carried down through the ages was that it was brilliant, that it remained for a week or so, and that it had

Sky and Telescope

The planets Mars, Jupiter, and Saturn arranged in a triangle as they would have appeared in the year 6 B.C., another miracle performed by the Hayden Planetarium projector

five points. With these clues, and with the necessary calculations, it should be possible to go back in time and reconstruct the night sky at the time of the birth of Christ. The only trouble is that the exact year is

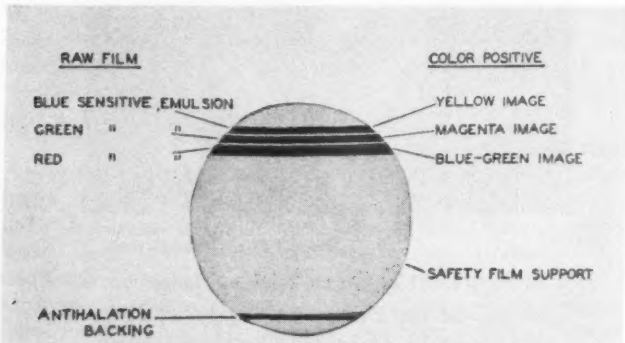
(*Continued on page 132*)

Color Photography

By KENNETH WIBERG, '48

PART I. THE FILM

CONSIDERING the large number of new color materials and the grandiose rumors of still greater things to come, this seems to be an appropriate time to stop and review our progress. Viewpoints and emphasis have changed so much that the practice of 1946 uses techniques that received hardly any mention only twenty years ago. Color photography has passed from the use of the cumbersome one-shot camera with its delicate light-splitting device, to the monopack which could be exposed in an ordinary camera. It has discarded the complicated positive processes which require precise registration of three separate images, and adopted the multilayered material processed by color development or by silver-dye-bleach.



CROSS-SECTION OF KODACHROME FILM

Figure 1

Processes based on the formation of separation negatives, or the use of color screens or lenticular film will not be discussed here as they are very rarely used by amateurs at the present time, and there seems to be no possibility that any of the processes will ever become widely used at any time in the future.

The first really successful monopack was Kodachrome, that is, the second film by that name produced by the Eastman Kodak Company. The first film with that name was based on a pinatype procedure. The physical construction of the new Kodachrome is illustrated by the cross-section (Figure 1). The top layer is blue sensitive, and is finally dyed yellow, the second emulsion layer is green sensitive, and is dyed magenta, while the bottom emulsion is red sensitive and is subsequently dyed cyan. Between the blue and green sensitive emulsions is placed a yellow filter. This filter is necessary since both the red sensitive and green sensitive emulsions are sensitive to blue also, and this yellow filter removes the offending blue light which might otherwise penetrate through the blue sensitive emulsion.

Although this film is normally developed by Eastman, a versatile amateur can process this film himself, if he has a good deal of patience and luck. However, this is not recommended. As Eastman's Kodachrome developing process is still more or less a secret, instead of making any conjectures as to the nature of their process, I will describe a homemade process for developing this film, one which should not be too radically different from the "correct" procedure.

The exposed Kodachrome film is developed in "depth developer," a modification of a popular amidol developer. This first development will reduce all of the exposed silver grains and leave only the unexposed grains intact. The film is now exposed to red light through an F filter through the celluloid back, and then developed in a cyan color developer. Next, the top layer is exposed to blue light through a C_4 filter and developed in a yellow color developer. Finally, the film is exposed to white light, developed in a magenta color developer, and bleached in Farmer's reducer. Further information concerning the composition of the developers mentioned here and in other places in this article are available on request, and were not included as they are not of general interest.

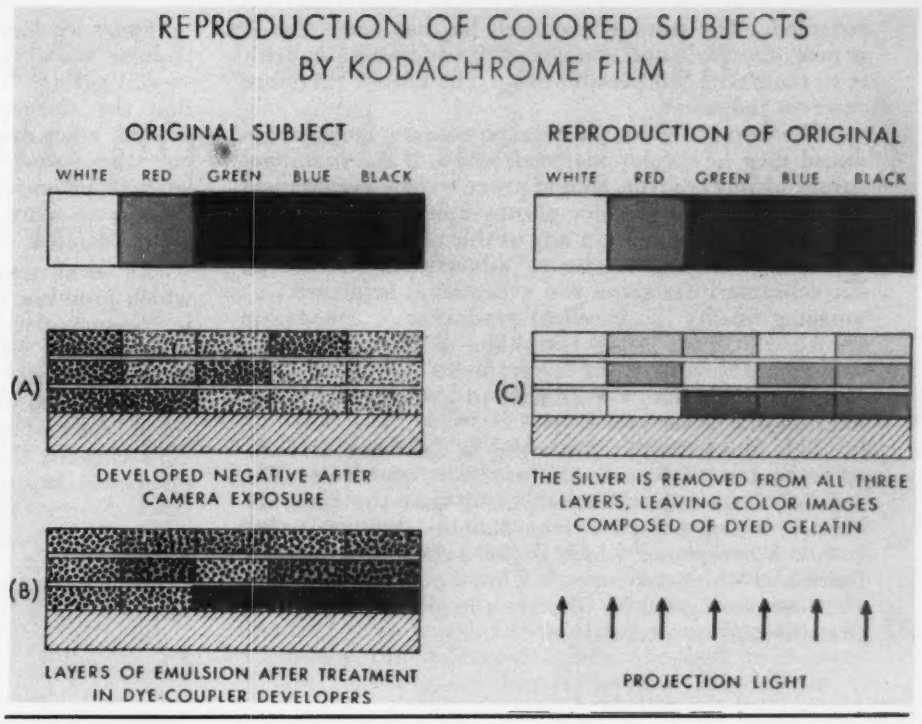
A later development of Eastman's color process which was received favorably, was Kodacolor. As with Kodachrome, this name was originally used for another process, but in this discussion the name

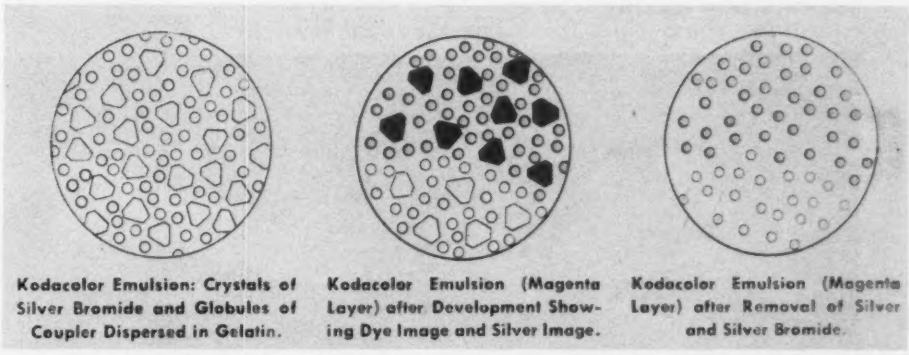
Packaging film in a large modern plant

Kodacolor will be applied only to the later process. The physical structure of this film is the same as that of Kodachrome, the only difference is that the color couplers are included in the emulsion. This slight change makes possible a very much simplified processing procedure. All that is necessary is a development in a 2-amino-5-diethylaminotoluene developer, short stop, bleach, and fix. This of course gives a color negative, but in this process, that is what is desired, as it is primarily designed for the production of prints on paper. The printing process will be described in a subsequent article. This process would seem to be ideal, but in practice, it is found to give poor color balance. However, the fact that its speed (ASA 25) is much higher than any other popular color material, and that it is available in all sizes of roll film, makes it a fairly popular process in those cases where critical color rendition is not necessary, such as in ordinary snapshots.

The recently marketed Anscocolor process is very much similar to the aforementioned films. The color couplers are included in the emulsion as in Kodacolor, while it gives a transparency similar to Kodachrome. The patent literature concerned with this film gives many interesting suggestions as to the actual composition of this film. In one of the disclosures, the following compounds are included in the layers: the blue sensitive layer contained p-capronyl-amino-benzoyl-acetamino-salicylic acid, the red sensitive layer, 1-hydroxy-2-carboxyl-5-dodecoyl-aminonaphthalene, and the green sensitive layer, 1-(4′-oxy-3′-carboxyphenyl)-3-(4″-dodecoylamino)-phenyl-5-pyrazolone. These are not the only ones which can be used, and are probably not even the ones being used, but they indicate the complexity of the materials necessary to fulfill all of the requirements of stability, low rate of diffusion, and correct color rendition.

The film processing is simple and the film is designed for processing in the average darkroom. The film is first developed in a depth-developer for about fifteen minutes, washed, and the silver formed removed with a one-half per cent chromic acid solution. The film is then washed for ten minutes, developed in a diethyl-p-phenylene diamine developer, rinsed, fixed and washed. The color rendition of this film is quite good, but the colors seem to be rather artificially bright, and subtle color differences are not too well

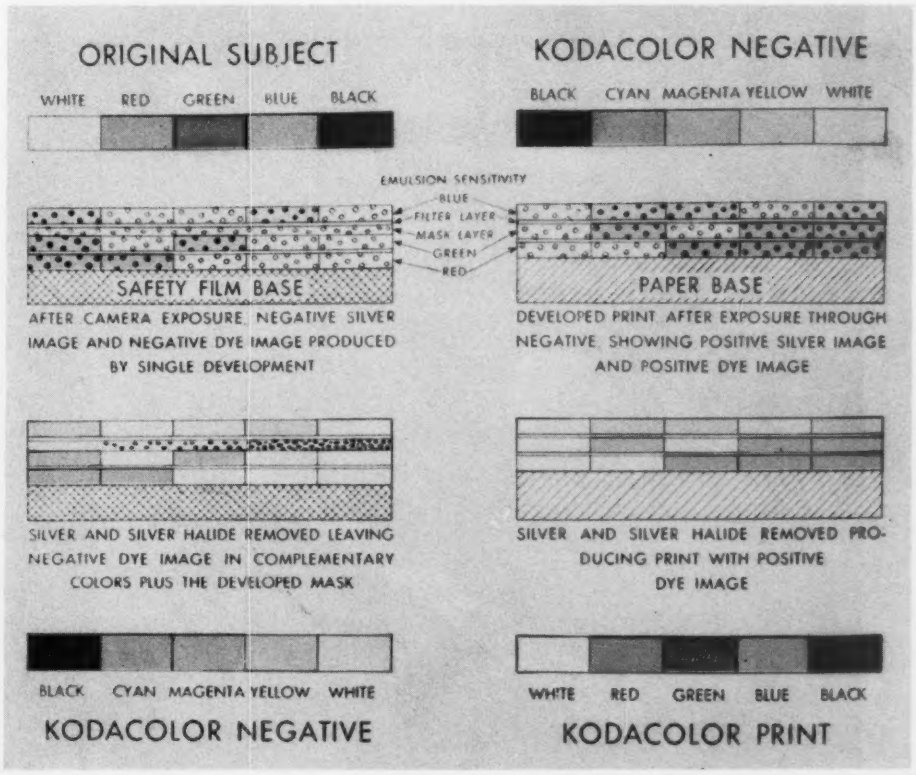

REPRODUCTION OF COLORED SUBJECTS
BY KODACHROME FILM
ORIGINAL SUBJECT
REPRODUCTION OF ORIGINAL
WHITE RED GREEN BLUE BLACK
WHITE RED GREEN BLUE BLACK
(A)
(C)
DEVELOPED NEGATIVE AFTER CAMERA EXPOSURE
THE SILVER IS REMOVED FROM ALL THREE LAYERS, LEAVING COLOR IMAGES COMPOSED OF DYED GELATIN
(B)
LAYERS OF EMULSION AFTER TREATMENT IN DYE-COUPLER DEVELOPERS
PROJECTION LIGHT



Kodacolor Emulsion: Crystals of Silver Bromide and Globules of Coupler Dispersed in Gelatin.

Kodacolor Emulsion (Magenta Layer) after Development Showing Dye Image and Silver Image.

Kodacolor Emulsion (Magenta Layer) after Removal of Silver and Silver Bromide.


ORIGINAL SUBJECT
KODACOLOR NEGATIVE
WHITE RED GREEN BLUE BLACK
BLACK CYAN MAGENTA YELLOW WHITE
EMULSION SENSITIVITY
BLUE
FILTER LAYER
MASK LAYER
GREEN
RED
SAFETY FILM BASE
PAPER BASE
AFTER CAMERA EXPOSURE, NEGATIVE SILVER IMAGE AND NEGATIVE DYE IMAGE PRODUCED BY SINGLE DEVELOPMENT
DEVELOPED PRINT AFTER EXPOSURE THROUGH NEGATIVE, SHOWING POSITIVE SILVER IMAGE AND POSITIVE DYE IMAGE
SILVER AND SILVER HALIDE REMOVED LEAVING NEGATIVE DYE IMAGE IN COMPLEMENTARY COLORS PLUS THE DEVELOPED MASK
SILVER AND SILVER HALIDE REMOVED PRODUCING PRINT WITH POSITIVE DYE IMAGE
BLACK CYAN MAGENTA YELLOW WHITE
WHITE RED GREEN BLUE BLACK
KODACOLOR NEGATIVE
KODACOLOR PRINT

recorded. The trouble may well be that since this is a new material, not enough work has been done with it to realize its full possibilities. The author therefore reserves judgment.

The world of color photography is now being introduced to a new color material, which, if the manufacturers' claims are true, should prove to be a very important contribution to color photography. As I have as yet been unable to obtain any of this material, I hereby quote from the manufacturers' advertisement, "Kodak Ektachrome Film gives you exceptional brilliance . . . amazing fidelity . . . excellent gradation . . . moderate contrast." Even after sprinkling a liberal dose of sodium chloride over the latter, there still seems to be hope that this film will be able to give normal reproduction of colored scenes.

This film is readily processed in the amateur darkroom by the same procedure used for Ansco color film, the only important difference being that the color developer is not a p-phenylene diamine derivative, but rather a compound which is "as safe as the average black-and-white developer." This should prove a boon to those photographers who are allergic to p-phenylene diamine and its derivatives.

Preparing the celluloid base on which the emulsion coating is to go

Since we have now discussed all of the currently popular color materials, we may indulge in a little crystal gazing. The indications at the present time are that the aforementioned monopacks will remain the popular color material for a good many years to come, but the speed will be increased considerably, the latitude increased, and the method of processing will become no more complicated than standard black and white practice.

As far as new materials are concerned, the only one which promises to become a reality in the near future is "Gasparcolor." The process seems to depend upon the catalytic effect of finely divided silver, whereby dyes are formed or destroyed *in situ* with the image. The procedure would be to include a dye in each of the three layers of emulsion, which are similar to those in Kodachrome, the exposed silver halide would be developed and finally the dye would be bleached in the places where the silver was produced during development. A bleach and a fix are all that are necessary to complete the process. This process would seem to have many good points, and may well appear on the market in the not too distant future.

Finally, I would like to mention two other very interesting processes, diazo photography and the bleach-out process. It has long been known that diazonium salts are sensitive to light. These compounds are destroyed or deactivated by light, particularly ultraviolet light. In this case, the diazonium salt can be coupled with a phenol to give a dye, and a direct positive is produced. This process has not as yet been applied to color photography, mainly because of the insensitivity of these compounds to wavelengths beyond 5000 A. The application of this process is still a possibility, however, and research is being carried out in an attempt to make it applicable to color photography.

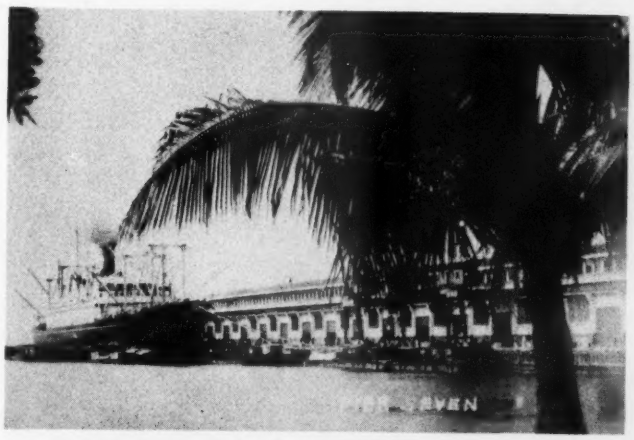
The bleach-out process is one of the most interesting and perhaps one of the most promising methods of producing color photographs, especially in those cases where great speed is not necessary, as in the case of making prints. The process is based on the fact that certain dyes are bleached by light of the wavelengths which they absorb. Thus, three tri-color dyes could be mixed into an emulsion, and the emulsion exposed until the dyes are bleached to the desired depth. This process works very well, except that it is extremely slow. But photographic scientists are at work developing sensitizers, and one may hope that their work will be crowned with success.

Many other processes have been proposed, but I have restricted the scope of this article to include only the processes which affect, or may in the future affect, the amateur photographer. In a future article, I hope to continue this discussion with a description of the main processes for obtaining color prints.

The Future of Industry in the Philippine Islands

By PEDRO PICORNELL, '47

AS far back as historical records go, the Philippine Islands have been a trade center in the Far East. Strategically located off the southeast coast of Asia, they mark the crossroads of Far Eastern trade. The Chinese traded with the islanders in pre-Spanish times



Manila prewar harbor facilities. Although badly damaged during the war, the harbor has been extensively rebuilt

and there are a number of records in existence today of the trading voyages of their merchants. With the coming of the Spaniards, Manila became the port where Asiatic goods were stored prior to their long journey to Europe by way of Mexico. From all over the Far East merchandise was brought to Manila, mainly by Chinese traders. There it was loaded on galleons which, if able to weather the storms of the Pacific and escape the clutches of English pirates, took it to be sold in European markets at a fantastic price. The coming of the Americans brought a tremendous development of the country, and a great market for its raw materials. Thus the exports of the Philippines grew and grew, and the country prospered.

But the economy of the country was based chiefly on agriculture. The exportation of raw materials brought in excellent profits, and all manufactured articles needed by the people could easily be imported from abroad, chiefly from the United States. Some manufacturing was done but not on a very large scale, although steps were being taken to encourage new industries. A short time before the war the manufacture of cement and ceramic products was started and promised much. But almost without warning, early in 1942, the Japanese marched into the Philippines and, for over three long years, the country was completely isolated from the rest of the world. The Japanese took everything they could lay their hands on, and what little there was in the line of industrial machinery was rapidly dismantled and taken to Japan.

With everything going out of the country, and nothing coming in but hungry Japanese soldiers, the country was being bled white. And the people, in order to survive, were driven to the end of their rope to think of new ways to get the little comforts of life. Gasoline and coal were unobtainable, but after some experimenting a kind of charcoal made from coconut husks was developed which proved fairly successful in running some of the machinery which was left, and even in running some automobiles after special gas producers had been installed on them. Several young chemists got together and, by using local materials, succeeded in putting on the market a decent line of cosmetics with which they made quite a lot of money. Medicines were nowhere to be found, although they were essential, especially for the resistance forces who had to contend against the tropical diseases as well as with enemy troops. Several of these units ran a sort of pharmaceutical laboratory in which some medicines were made out of local materials and even some crude substitutes developed, all this without the aid of good facilities or

The Manila business district after the Battle of Manila, February 1945

even knowledge, since they were usually run by young, unexperienced chemists or students. These are but a few of the many local products developed during those years.

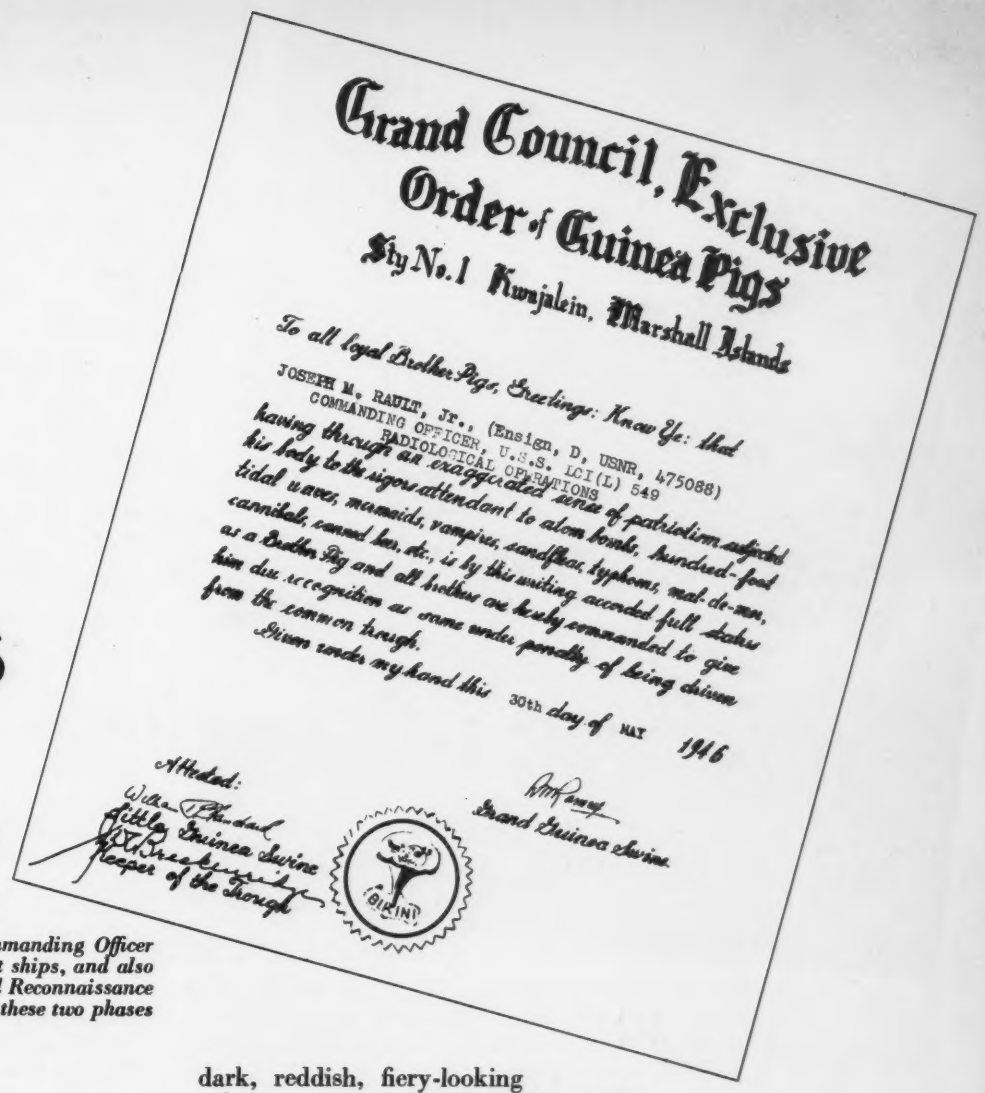
Thus, under the pressure of necessity, the Filipino has come to realize that he can produce manufactured goods. And now, with the granting of independence, he is more eager to expand the potentialities of his country. The country has suffered very heavily during the war. What little industry it had is no more. But with American help the country is slowly getting back on her feet, and with a few years of peace and hard work, the country will be back in the prosperity it enjoyed before the war.

The Philippine Islands are very rich in natural resources. Their gold mines are famous for the quantity and quality of their product. Located chiefly in the mountainous region of Luzon, they produced a total of $32,000,000 in 1938. The gold usually exists with quartz, although rich placer deposits are also being

(*Continued on page 124*)

A signal fire in history—
the Able bomb at Bikini
Army-Navy photo

Bikini Allows Thirty Seconds



Grand Council, Exclusive Order of Guinea Pigs

Sty No. 1 Kwajalein, Marshall Islands

To all loyal Brother Pigs, Greetings: Know Ye: that JOSEPH M. RAULT, JR., (Ensign, D, USNR, 475088) COMMANDING OFFICER, U.S.S. LCI(L) 549 RADIOLOGICAL OPERATIONS having through an exaggerated sense of patriotism subjected his body to the vigors attendant to atom bombs, hundred-foot tidal waves, mermaids, vampires, sandflies, typhoons, mal-de-mer, cannibals, canned beer, etc., is by this writing accorded full status as a Brother Pig and all brothers are hereby commanded to give him due recognition as same under penalty of being shivved from the common trough.

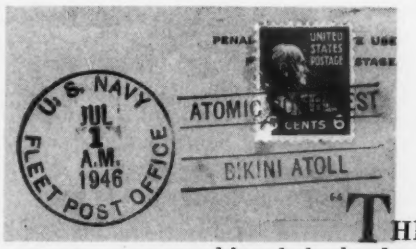
Given under my hand this 30th day of MAY 1946

Attested:
William J. Rhodes
Little Guinea Swine
Keeper of the Trough

Grand Guinea Swine

By
JOSEPH M. RAULT, JR., '48

Editor's Note: The author is the former Commanding Officer of the U.S.S. LCI(L) 549, *one of the Bikini target ships, and also former skipper of one of the Radiological Safety and Reconnaissance Patrol boats. This is a story of his experiences in these two phases of "Operation Crossroads."*



"THIRTY seconds to go," blared the loudspeaker on the fantail of the Navy Transport *Bayfield*. Before donning my goggles, as a last check, I took a look at my crew huddled below, then slipped into position facing the atoll. Tension and expectancy were sensed everywhere.

"Two seconds — bombs away, bombs away!" was relayed from the unseen plane. I began counting to myself, "One, two, three — ." Multifarious thoughts ran through my mind in this short time. "Nine, ten, eleven — what if it doesn't go off? Sixteen, seventeen — suppose it misses the target? Twenty, twenty-one, twenty-two — will the concussion — there!" A great whitish flash appeared just above the horizon, followed immediately by another, emerging from the surface and spreading out almost instantly in an arc about one-half mile in radius. Through my goggles it appeared to be a reddish white, a little less in brilliance than the sun. Almost as quickly as they occurred, the flashes died out, and I removed the protective goggles to see a huge white cloud pyramiding upward, as if rising from the water of Bikini.

At first it was hard to differentiate this from the low-lying cumulus clouds, but, as it rose higher and higher, billowing and mushrooming out into the characteristic "Atom Shape," definite colors appeared — a dark, reddish, fiery-looking substance was within the white middle or stem, topped by a pinkish-white cap that almost resembled "cotton candy" bought at a circus.

All observers were now looking. About two minutes after the detonation we heard the sound of the explosion — low and rumbling.

Slowly, as the cloud rose, we watched the wind disperse it at different altitudes. Finally it traced a huge "Z" across the sky. In the meantime, radio-controlled drone planes were darting in and out of this poisoned upheaval, collecting invaluable gas samples for future analysis.

At the end of fifteen minutes we could see black smoke rising from "Blandy's Inferno," indicating damage — with the extent of which I am sure the reader is by now familiar; crushed superstructures, distorted hulls, twisted, sunken ships, an almost unrecognizable carrier *Independence*, not to even mention the radiological results. These effects were caused by perhaps the most widely-publicized event in the last year, and one that the world will long remember. Let us turn back time a couple of months to see some of the factors that went into the preparation and make-up of this history-writing incident.

The mountains of the Isle of Oahu shone in the western sunlight on Sunday afternoon, May 19, 1946, and gazed out on two thin columns of LCI's standing out of the channel entrance to Pearl Harbor. From the conn of the lead ship, I could see the island slowly dropping back and could watch our advance by noting the change in color of the water. "At last we are under way," I thought. It really did not seem that the past few months had been long — actually too full to justify the time that passed. Weeks and weeks were crammed

With a sudden brilliance comparable to that of the sun, the detonation of the Able bomb lights the sky

full of preparation for the tests. We went into dry dock for complete repairs, filled all allowances of supplies and machinery parts, installed blast gages and deck scratch compression gages, removed most of the gun mounts, stripped the ship of all excessive weight including unnecessary personal gear, attended conferences, gathered necessary navigational data, painted frame numbers and draft lines on the hull exterior, and completed the volumes of paper work that legalize and record the procedure.

A sharp crack suddenly rent the air, disrupting my thoughts, and, turning, I saw the wooden mast of the ship behind us snapped in two by an offshore wind. "The Navy certainly isn't going to waste good ships as targets," I mused. I was more convinced of this after the next twelve days at sea, when I witnessed five major breakdowns. In fact this voyage from Pearl Harbor to Bikini would make an interesting story alone — perhaps one all too typical of our Amphibious Forces.

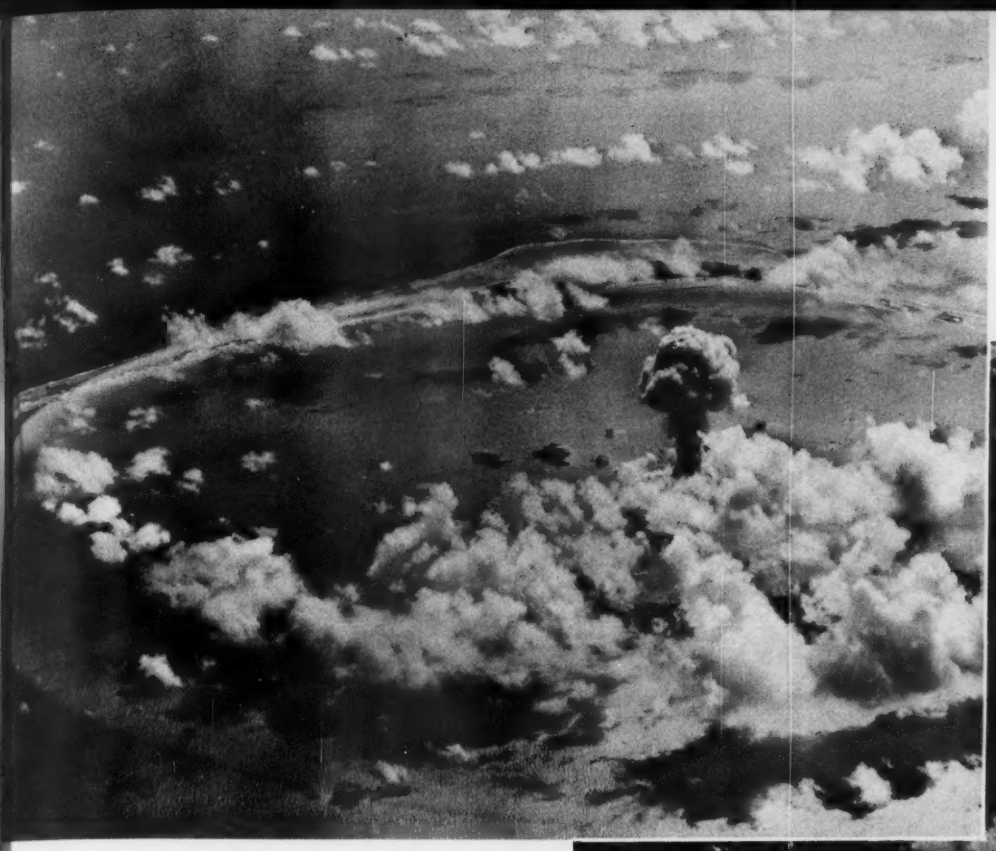
It was a great deal warmer on June 1. The strong easterly trade winds seemed to help push us slowly ahead into a break between the coral isles that now lay just off our bow. Inside the lagoon, twenty-two by ten miles, I could make out a vast floating armada, made up of one hundred ships of all types and three nationalities — American, German, and Japanese. The anchorage was a picture of many shades of Navy gray, spotted with the red, white, and green of our hospital ships, and the orange target center — the *Nevada*. The history of our Navy over the past decade and a half was well written here and could be read in the names of such queens as the *Pennsylvania*, former fleet battleship and flagship, the *Saratoga*, a cruiser-hulled carrier of the old fleet, the battleships *New York* and *Arkansas*, the cruisers *Salt Lake City* and *Pensacola*, and also those that played a part in the latest chapter of our history — the German cruiser *Prince Eugen*, the Japanese battleship *Nagato* and cruiser *Sakawa*. On the islands enclosing this maze of ships were constructed the steel towers and structures to be used for radio, television, radar, and motion picture emplacements.

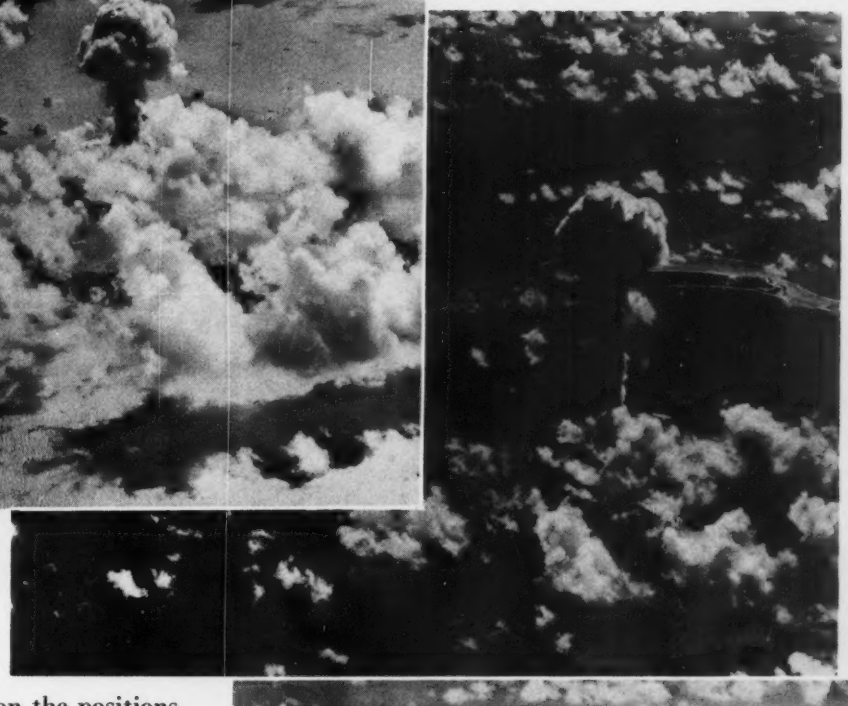
Upon standing in Enyu Channel, the entrance to Bikini, a pilot boat passed alongside and gave me our target anchorage, hitherto secret. After accurately finding this spot, which was extremely important in the experiment, we dropped both anchors and then almost immediately started the four weeks of readiness. Our main job was to determine completely the present condition of the ship and record the same. This required inspections of the hull, voids, cofferdams, machinery, electrical system, rigging, guns, compartments, fittings, frames, bulkheads, and even the paintwork.

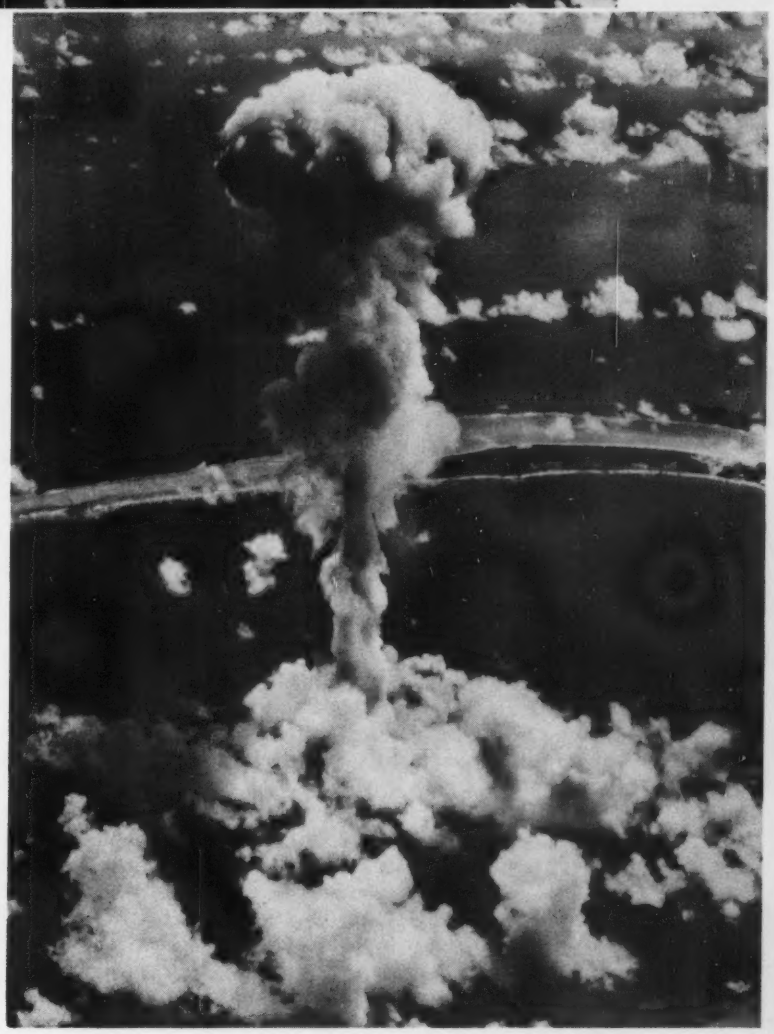
Stability measurements were noted, after measurements of draft, trim, list, and the period of roll. List was measured in degrees with a clinometer, which works on the plumb-line principle. The period of roll was found by "sallying ship" — having the crew run en masse from one side to the other until a good roll was developed and then timing the period the ship took to roll from one side to the other and back again. For an LCI this is about six seconds, and stays about the same for different degrees of roll. The aircraft carrier *Saratoga* with her crew of many hundreds made quite an impressive scene doing this experiment, but I do not think the results obtained were fully appreciated by her seamen's legs.

The target area at the instant of detonation. Note the ships leaning away from the blast

Official U. S. Navy photograph





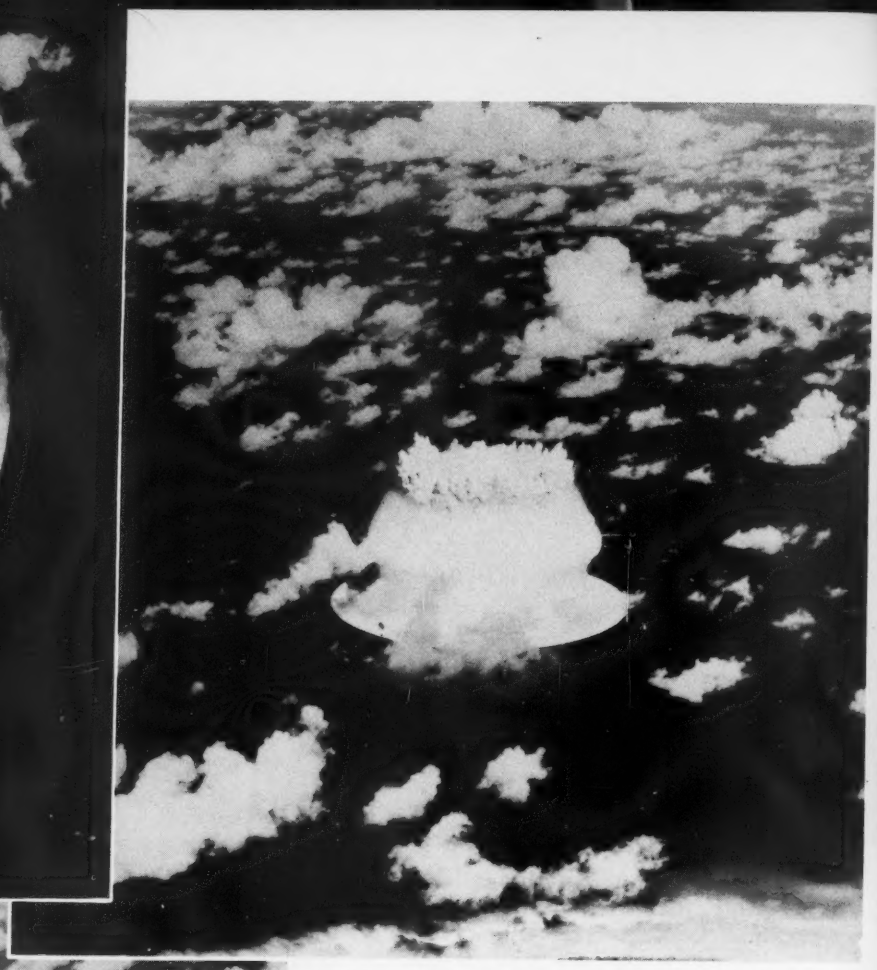


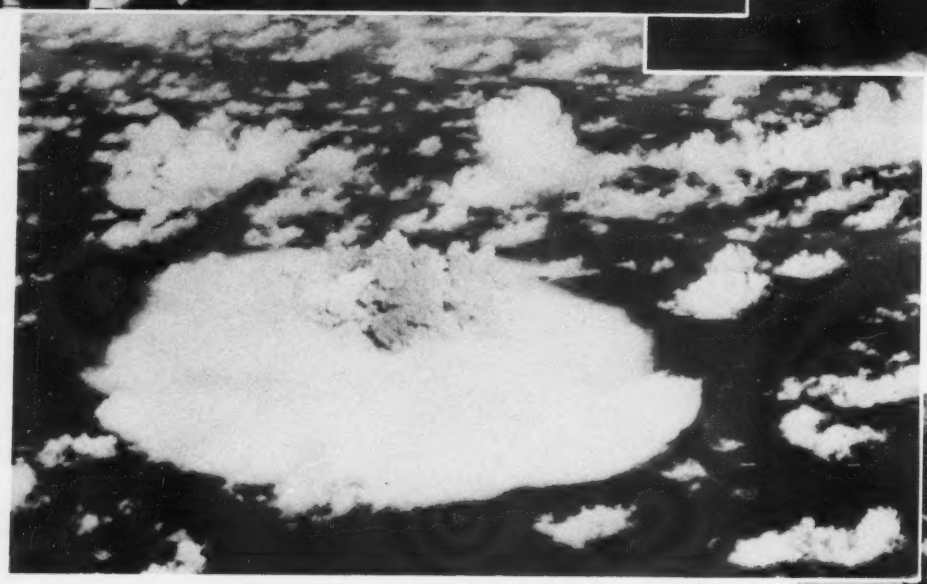
Three different stages in the growth of the cloud
Army-Navy photos

It was then the morning of June 30 — Able, the day set for the air drop, minus one day. The ship was finally prepared for the target vessel role she had awaited over six months. With her fittings dogged, colors struck, and evacuation flag "yoke" hoisted, I checked on the positions of the densitometric film badges and chemical pills placed around the ship to measure any radiation, and then joined my crew in our small boat. We were loaded with everything essential to the rehabilitation of the ship — chronometers, radios, compasses, sextants, fire fighting and damage control equipment, official records, and, of course, the inevitable Navy "Joe-pot." Upon leaving the *549* one honestly did not know what to expect on our return. The trip through the target area that morning was one that I will never forget. Small boats were evacuating personnel from the target vessels while others were finishing last minute jobs. Sailors were performing such unprecedented tasks as tying goats to pens on their ship's forecastles, hoisting cages of rats and mice on the halyards, and putting boxes of insects in various compartments. However I imagine the most amusing job was performed by the person who was in charge of the guinea pig assigned to the stateroom of the Executive Officer of one of the target transports.

The next morning, at sea, eighteen miles away, there was little need for the transport's boatswain to order the setting of watertight condition X-ray, because the Steward's Mates had already accomplished this "all hands" feat alone; likewise there was no real necessity for the order "All hands, assemble on deck," because everyone was already there — some even with lifebelts and their prized personal possessions. At ten minutes before release time, each Captain refreshed his crew in the safety precautions, had them sit facing away from Bikini with their heads in their arms, and then donned special black, neutral density goggles. With mine on, I could just make out a white disc when looking directly at the sun. Then, "Thirty seconds to go," blared the loudspeaker . . .

One of the most interesting and perhaps least known features of "Crossroads" was the mission and work





Above, left: The Baker bomb spout just after the explosion

Above, right: The Baker cloud begins to take shape *Army-Navy photo*

Below: The fully developed mushroom of the underwater bomb

Left: Looking much like the surrounding clouds, the Baker bomb gases begin to spread. Note the shock wave patterns on the water *Army-Navy photo*

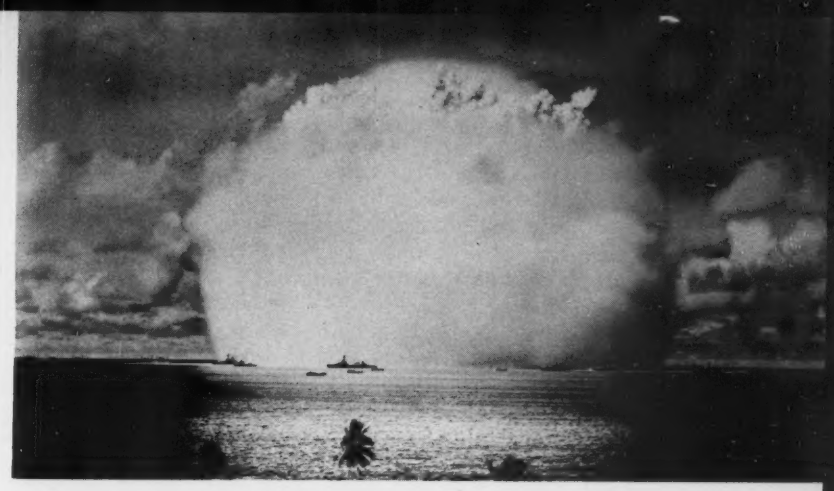
performed by the Radiological Safety and Reconnaissance Patrols under Commander Draper L. Kauffman. These patrols consisted of five units, each containing one fast Navy gunboat and four speedy thirty-six-foot *LCPL*'s. Manned by Army and Navy personnel, and "Radiological monitors" who were usually scientists, these patrols entered the target area after the Able test and, by means of various instruments, determined the position and amount of radioactivity and the condition of the water and ships. This information was then radioed back to the Operation control room on the flagship, where it was evaluated.

I was fortunate in being assigned to this patrol for the Baker Test and was put in charge of one of the *PL*'s. For three weeks I attended briefings and critiques by the scientists, got the boat in shape, renewed the equipment, and by Baker Day — the date of the underwater blast — had made trial runs, studied the lagoon waters and island features, and was working well with the rest of the patrols. The next morning, Thursday, July 25, standing on the deck of our mother transport,

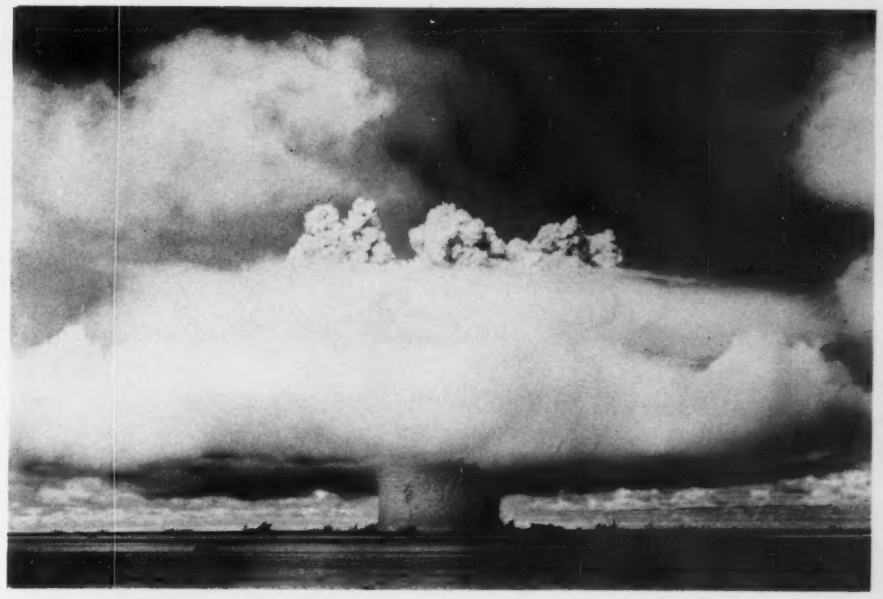
Totally obscuring anything near by, the Baker bomb's cloud takes on a spherical shape during its evolution

Henrico, and looking out upon the target ships which could be plainly seen at our distance of only eight miles, I waited for the world's fifth atomic bomb to be exploded. Once again came the humdrum counting of seconds, climaxed by the detonation itself. Simultaneously the entire lagoon and all in it appeared to shake, while a gigantic water boil seemed to swell up, burst, and shoot into the air in the same microsecond. It continued, boiling, churning, frothing; from it I saw a large black object appear and sail through the air, becoming lost beneath the ocean waters. It was probably part of the *LSM* that was connected with the bomb laying. As the cloud rose, it swelled out, lost momentum, and started falling — down and outward. I could now see this unleashed churning mist slowly advancing and enveloping ship after ship. My first thought was that this deadly substance might come out as far as we were, but soon this fear was calmed by noting the cloud's loss of energy when the outer fringe of target vessels was barely curtained. In a minute or more we heard the sound; against the ship's side the waves were now breaking and continuing out to the coral reefs. Slowly the mist fell and cleared, the waves lost out, and we could see the vessels once again. Through my Navy 7 x 50's I observed that the *Saratoga's* characteristic superstructure was badly battered, and that her flight deck was ruptured. Behind her there was an empty space where the old battleship *Arkansas* had been — a few minutes later a plane observer verified her immediate sinkage. It was very hard to determine anything about the others. In a little more than an hour we were sailing into the channel entrance and being dropped to the water in our boats, fully loaded. Each unit patrol had its particular assignment, its accomplishment depending on the radioactive condition of the area. Several groups went to some of the islands with landing parties to retrieve precious films before they were spoiled by the activation — including the ones you saw the following week in the newsreels. The rest of us had certain sections of the target area to evaluate. My boat had the western line of destroyers and transports, plus the *Prince Eugen*. We were well equipped with radiation detection instruments — the well-known Geiger-Mueller counter, the Scott meter, the Ion meter, and other auxiliaries — and each man carried dosimitry film badges. By these means we could tell exactly how much radiation we were receiving at any particular instant, and also the total dose we had accumulated. Thus we could foretell approximately how much longer we could stay in any area. Finer calculations were made at night from our film badges by the technicians of the Radiological Safety Section under the direction of Col. Stafford L. Warner. They would calculate how much dosage each individual had absorbed.

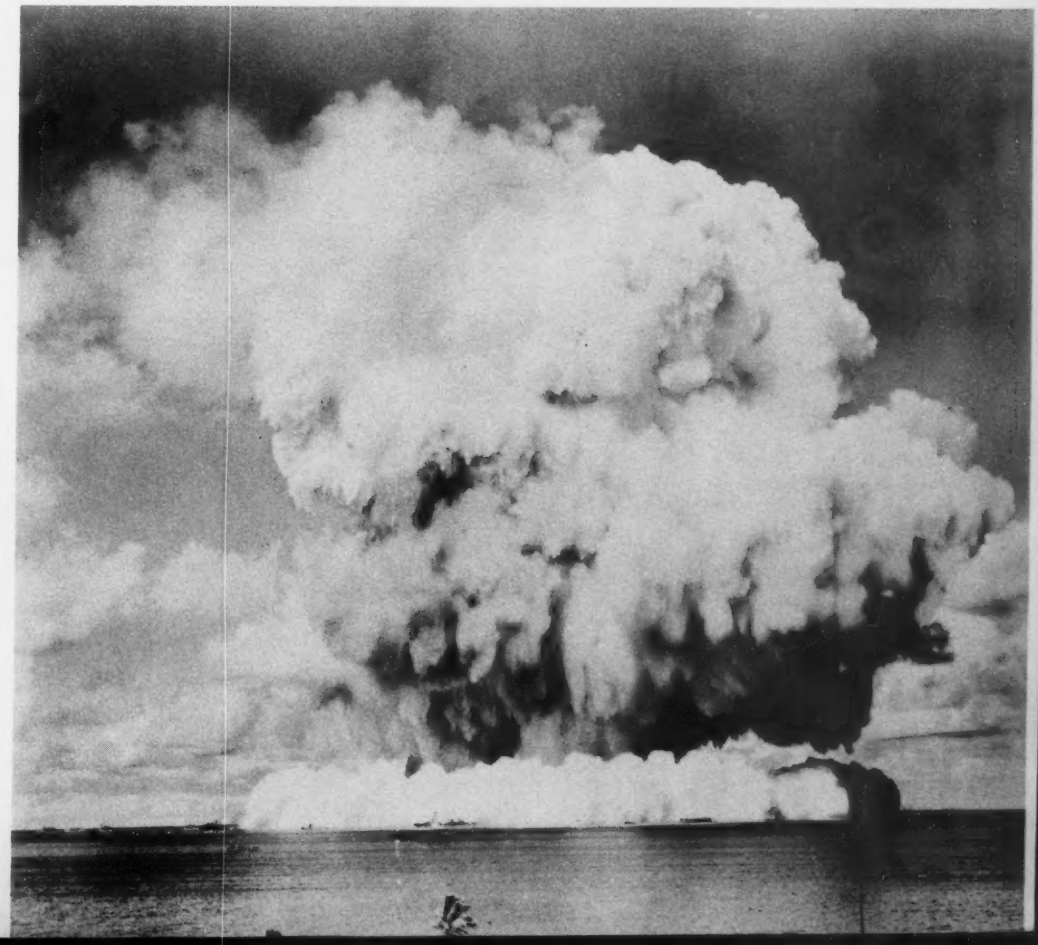
The maximum allowed dosage was one tenth of a Roentgen per



Standing on end in her last public appearance, the Arkansas *makes a dark pattern against the rising spout of the Baker bomb*



Its upward momentum gone, water from the Baker bomb begins to fall back towards the lagoon surface



The grand "Old Lady" in her death dive. The Saratoga *goes under*

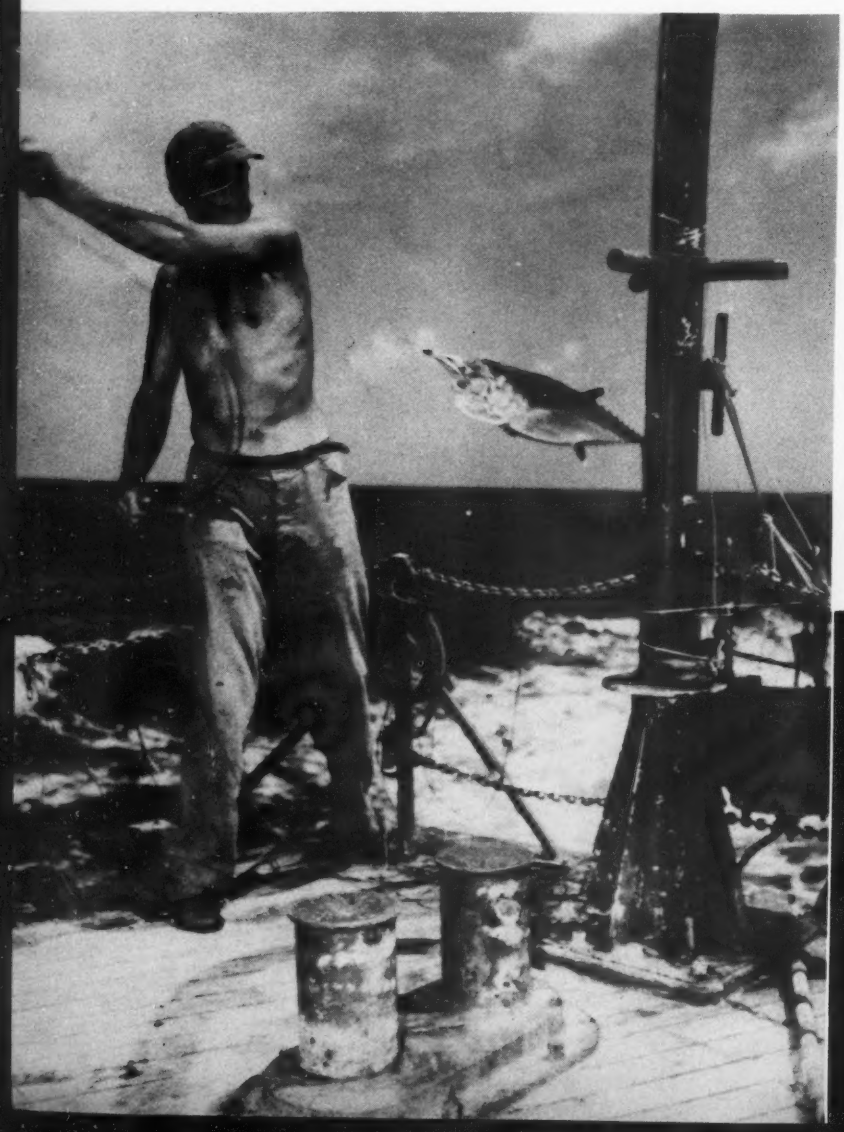
twenty-four hours, so if we were operating constantly in an area that averaged approximately two Roentgen, after an hour and twelve minutes, our patrol would have to leave, not to re-enter any contaminated place at all until the next day. Some trips, we remained out for twelve hours or more, while other days when working near the ships we would use our tolerance in a couple of hours.

A Roentgen may be defined as that dosage of radiation that is equivalent to the formation in one cubic centimeter of air at standard temperature and pressure of one electrostatic unit of positive or negative ions. This is equal to 2×10^9 ion pairs for air, or 1.6×10^{12} ion pairs for human flesh.

Although the bomb releases great amounts of neutrons when exploded, these dissipate almost immediately. Most of our measurements were made on the beta and gamma rays caused by the fission products or by radioactivity induced in materials by the neutrons. Alpha rays caused by the plutonium were generally of too short a wavelength to be picked up by our instruments.

Bringing in a unique specimen for radiobiological study *Official U. S. Navy photo*

Self-portrait of a radioactive fish taken from the waters of the lagoon after the Baker test. The fish was simply laid on photographic paper for a few minutes. This is the result *Army-Navy photo*



Coming back to the morning of the underwater test, we were cruising in our section of the target array while I was taking navigational positions and while one of the monitors was reading the amount of radioactivity in the air. At the same time men were taking water samples from the lagoon, while still others had the unenviable job of scooping up all the dead fish and animals and other floating materials that we came across. Preliminary readings were made on these on the spot, and the specimens were saved for future dissection by Dr. Lauren R. Donaldson's Radiobiology Group, who would take counts of their various organs. Most of the fish thus caught were highly contaminated. All of this data combined with the time it was taken was then radioed back to the flagship control room where an up-to-the-minute picture of the condition of the lagoon was being kept. From our reports and those of the other patrols, the "sour" — too highly radioactive — and "sweet" — or safe — areas were determined, and by these results the time for the re-entry of the Task Force was determined.

In the boat we kept heading in towards the center of the target array, taking a series of these readings until we hit the tolerance or one-tenth Roentgen line, and would then back out and try again in another spot. If a target ship was in our range we would take readings by her, provided that she was not highly contaminated. We could not even go near many. About two thousand yards from my boat I could now see the *Saratoga*. It was now afternoon and all morning she had been getting lower by the stern. Her flight deck amidships was dished and bulged and her stacks were ruptured. The water was just up to her fantail. Suddenly, her stern started slipping, and she continued going under until her bow, poised in the air, was tugging at her anchor chains as if trying desperately to

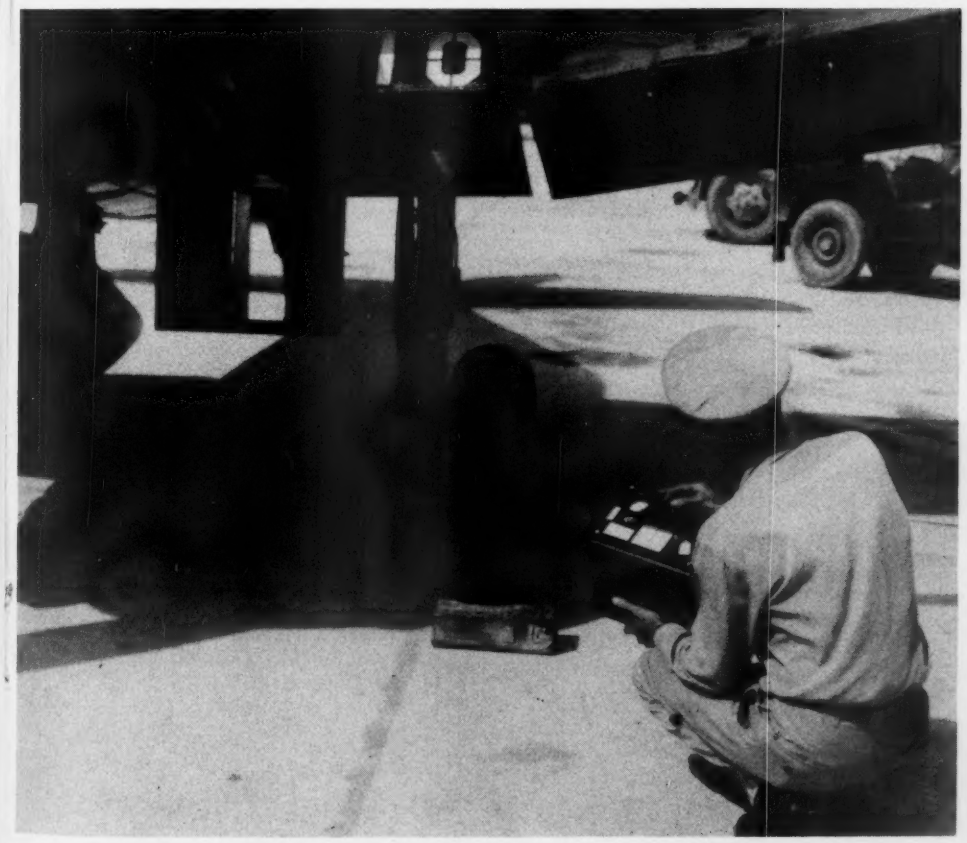
The author's ship, the U.S.S. *LCI 549 at Pearl Harbor*
Official photograph

stay up. This was of no avail, and at 1610 the gallant "Old Lady" died.

Continuing the patrol, we next came upon an overturned landing craft, drifting with the tide. It had been one moored near the middle of the target ships. Many ships had bad lists on them or were down by the head or stern; their continuous immersing indicated plate leaks below the waterline.

In the center of the array, where humans could not venture, radio-controlled drone boats were dashing around, picking up samples of water. Overhead drone planes were zooming, checking up on the air radiation.

In the ensuing days, we made similar trips, some long and a few short, depending on the field intensity in which we were working. Some of the work included gathering more radiobiology specimens. There were several methods we used. For small fish, we planted poison under the coral heads in shallow water and merely scooped up the dead bodies as they floated to the surface. Many of them thus caught were thought to be new species since they had never been seen before. The larger fish were speared and poisoned in deep water. With divers' suits we were able to gather bottom samples from the lagoon floor. The sights seen down there around the coral growths are beyond description. In medium depth water we put on flippers and dive masks, and with an underwater steel bow and arrow got further samples. When on routine runs, we would troll for the very large fish. Once a fifty-pound tuna pulled one of the boats off course before being landed.



Checking one of the returned drone planes with a Geiger-Mueller counter before removing the sample boxes attached to the wings *Army-Navy photo*

One third of a year has passed since the submarine bomb was exploded, and still, the majority of the ships in the experiment are nonhabitable, sitting very radioactively on the beaches of Kwajalein, two hundred and fifty miles below Bikini. It was decided to tow them to the latter place for the safety of the monitors who are to keep check on them. Many, many more years will probably pass before Bikini Atoll and her twenty-three islands are ready for rehabilitation. The United States Navy will never again see the ninety-five thousand tons of her ships that are resting on this lagoon floor because of two bombs. These are but a few of the effects of the atomic bomb—a weapon powerful enough to paralyze a whole fleet, to kill any living thing caught within its lethal range, to burn and crush battleship hulls. Truly, you have just read the story of experiments with a poison weapon — the most potent ever to face humanity. If a sixth is ever detonated, and I hope that catastrophe never occurs, the effects may be somewhat different from those just described, but of one thing we may be certain — there will be no warning voice saying, "Thirty seconds to go!"

A pillar of surging water flies skyward as the Baker bomb is detonated

Army-Navy photo

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Can You Do It?

THE FIFTH IN A SERIES OF MONTHLY BRAINBUSTERS

THIS MONTH: A couple of the old classics—one easy and one hard!

Problem 1: A hunter heading for the wide open spaces desires to travel on the train and buys his ticket accordingly. Upon arriving at the station, ready to leave, he is told by the conductor that he may not take his gun with him in the coach. Inquiring at the baggage car, he finds that the gun is unacceptable there too because of its excessive length of five feet two inches, since the baggage agent is forbidden to accept for shipment any article whose largest *dimension* is greater than one yard. What should our poor hunter do?

Problem 2: A and B are playing a game. A is to flip a coin until it falls "heads," at which time the game stops and the players settle up according to the following conditions: B is betting on "heads" and is to wager a set sum of money for each toss of the coin. A, at the end of each game, is to pay B the sum of 2^{n-1} dollars, where n is the number of throws it took to complete the game. Thus, if the game took three throws to come to an end, A pays B four dollars, while B pays A three times his regular fixed bet. How large can B's fixed bet be, so that he still can expect to win over a long period of time?

J. W. W.

(*Answers to last month's problems are on page 126*)

The Dragon's Den

For a Brave, New World . . .

It has been a little more than four years since the Metallurgical Laboratory at the University of Chicago carried out the first self-sustaining atomic reaction. From the mass of details and secrets about the Atomic piles which have produced the tremendously destructive forces at Hiroshima and Nagasaki, can be withdrawn this salient fact: Atomic power, though dangerous, can be used for peaceful, non-military purposes. Atomic power does *not* mean atomic bombs.

Atomic Development Authority. Sounds fantastic, doesn't it? And yet, this organization might be an actuality in the very near future — if the recommendations of the Acheson-Lilienthal Board of Consultants are accepted. Basically, A.D.A. would be an international corporation, owned and operated by the member nations, and possessing full control over the use of atomics in the world. A.D.A. could license the use of non-dangerous atomic power and keep all dangerous activities and researches in its own hands. Since it is possible to denature all fissionable materials, A.D.A. would safely furnish atomic fuel or other similar materials for research and manufacturing. Already, radioisotopes are being sold by the Clinton Laboratories — isotopes of elements like yttrium and illinium are available for comparatively low cost. Right now, these low-cost radio-elements are being used in hospitals and laboratories for medical and biochemical work, as well as in pure chemical research. An atomic power plant has been designed to produce electricity absolutely anywhere on the earth for a cost slightly higher than that of coal. Tibet has been mentioned as a good place for an atomic plant; one airplane could fly in the year's fuel. Tibet, now a semi-agricultural country, whose inhabitants have a rather low standard of living, could be industrialized and thus add to and benefit the whole world's economy through trade.

Thus far, the whole idea of the A.D.A. has not been accepted. Russia feels that the invasion of national sovereignty which such a group would entail is not worth the benefit to be derived. But, since even the most "optimistic" of our atom scientists has placed reproduction of the process (and bombs) at twenty-five years, probably ten, then there exists the vital necessity of having to form some sort of international organization with partial or full control over atomic energy.

The greatest source of annoyance to the research scientists is the fact that A.D.A. would have full control (as do most governments today) over all forms of atomic research. They protest against the stifling of free science and freedom of choice. We all agree with them but — is there not also the cause of world peace to be considered? A.D.A. will probably be the safest and most fruitful method of preserving world peace and, in time, will bring the nations of the world more closely together.

* * * *

And You . . . ?

Perhaps the Tech student thinks that this has very little significance in his life. Oh, sure, it's important, but . . . it'll never affect him. Well, you're wrong — every one of you is vitally concerned with the future of the A.D.A. or any other means of national or international control nations see fit to adopt. In fact, many of you may well be working for the Authority as an electrical engineer or as a physicist or chemist.

T.E.N. thinks that you ought to be concerned. On Tuesday, December 17, 1946, Joseph M. Rault, former naval officer, gave a talk on Bikini, describing the power and destruction caused by the atomic bomb. It was accompanied by pictures illustrating well the A-bomb explosions. The Lecture Series Committee, which usually presents very worthwhile talks, co-operated with *T.E.N.* in this.

* * * *

A word of congratulation is in order here for the new board members. Keep up the good work!

E. M. K.

AIRCRAFT MANUFACTURE

(*Continued from page 99*)

aircraft factory is like a river which is fed by hundreds of tributary streams. Each stream carries parts to the proper point on the assembly line where they are added to the forming airplane. A chain running in a groove along the factory floor pulls a line of airplanes from one end of the plant to the other at the rate of a few inches a minute. All along the line, major assemblies and small parts are added by the tens and hundreds. Motors, propellers, tail surfaces, wings, wheels, radios, instruments, rivets, paint; all are added at the proper moment.

Another sight, familiar to an automotive engineer, is that of the huge presses used in the making of formed sheet metal parts. These gigantic machines, towering twenty feet above floor level, are capable of exerting pressures of thousands of pounds per square inch in the bending of sheet metal ribs, brackets, and formers.

Once the assembly line is rolling smoothly, however, the aircraft engineer cannot relax because, whether in war or peace, a constant stream of information is coming in to indicate that his plane is rapidly becoming obsolete. This is not the designer's fault. Battlefield experience, information captured from the enemy, or advances made by his own and other companies make it necessary for him to revise his plans if he is to stay in the business. Revising a well-set-up assembly line which is turning out perfectly good airplanes is a heart-breaking process, yet during the war, this had to be done with utmost speed. Where it was not possible to alter planes at the factory, they were flown to points where the latest battle-proven changes were incorporated. This was often done right behind the lines, as in the Pacific theatre.

F4U-4's at the end of the line — *United Aircraft*

His lamp could burn for 30 years

on the extra power produced when 2 boilers replaced 6

IN PLACE OF SIX BOILERS, a big eastern power company is now installing *two*. These two modern boilers generate nearly twice as much steam as the original six . . . help produce far more electric power, too.

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This B&W boiler installation typifies the progress made during recent years in raising steam generating efficiency—progress in which B&W has consistently lead the way. B&W, old in experience, has pioneered important advances in many other fields too—yet B&W is still young enough to have new ideas for all industries on present problems and future plans.

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Many kinds, for many kinds of work . . . research and development, technical and economic planning, operations which involve the manufacturing, construction and maintenance of telephone facilities.

Telephone engineering is broad in scope but includes intensive study of a wide variety of specific problems. Much of it requires the special knowledge of electrical, mechanical, industrial or other engineers. All of it requires the engineer's background, his understanding of scientific principles, his trait of weighing the facts and deriving logical and workable conclusions.

With our greatest expansion program in history under way the work of the telephone engineer is more important than ever. In the next few years $2,000,000,000 will be spent for new buildings, new equipment and plant facilities.

The engineering task involved in this program, as well as in the normal operation of the industry, means just one thing: qualified engineers who choose telephony as a career will find their lives packed with interesting and satisfying work.

There's Opportunity and Adventure in Telephony

BELL TELEPHONE SYSTEM

What you should know about the TIMKEN BEARING

Design

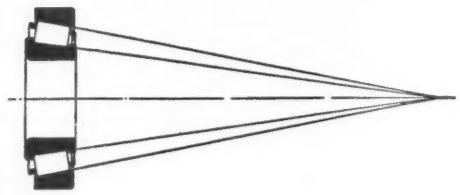
ESSENCE OF PERFORMANCE

Timken introduced the tapered principle over 48 years ago to obtain an anti-friction bearing with the ability to carry radial loads, thrust loads or any combination of the two. During the ensuing long period of engineering development and experience, a constant refinement of design has taken place, making the Timken Bearing of today supreme in performance.

Here are the three most important features exemplified in the design of the Timken Bearing.

1. TRUE ROLLING MOTION

This basic necessity is accomplished by making all lines coincident with the tapered surfaces of the rollers, cup and cone, meet at a common apex on the axis of the bearing, Figure 1. True rolling motion always has been incorporated in the Timken Bearing.

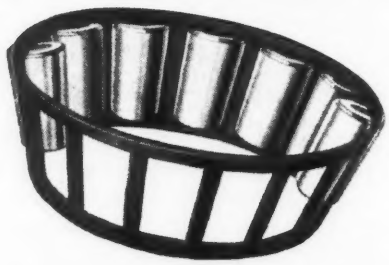


2. POSITIVE ROLLER ALIGNMENT

During the development of the Timken Bearing, as speed, load and accuracy requirements increased, various methods were used to stabilize the rollers and prevent them skewing on the raceways. The problem finally was solved by so designing the roll end and cone rib, that when generated during bearing production, perfectly smooth, mated working surfaces are obtained at the contact area, which keeps the rollers positively and permanently aligned on the raceways, reduces friction at this vital point to the minimum and eliminates initial wear. The light areas on the ends of the rollers in Figure 2 show generated contact of roller ends with cone rib.

3. MULTIPLE PERFORATED CAGE

All the openings in the Timken Bearing cage, Figure 3, are stamped out in one operation by means of multiple perforating dies made to extremely close precision tolerances. This assures exact center-to-center spacing of the rollers around the periphery of the raceways, so that every roller takes its full share of the load when the bearing is in operation.



A thorough knowledge of Timken Bearing design and application will be one of your best assets when you graduate to enter the professional engineering field. Begin to acquire it now.

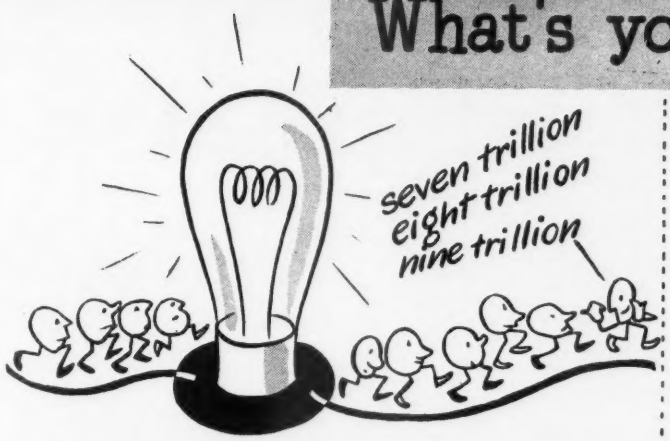
THE TIMKEN ROLLER BEARING COMPANY, CANTON 6, OHIO

TIMKEN

TRADE-MARK REG. U. S. PAT. OFF.

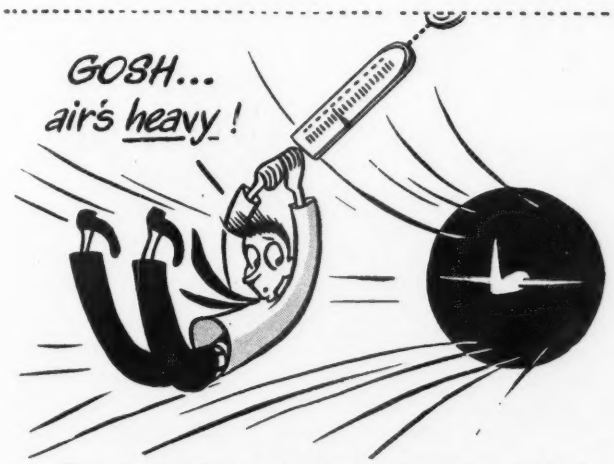
TAPERED ROLLER BEARINGS

What's your S.Q.*?



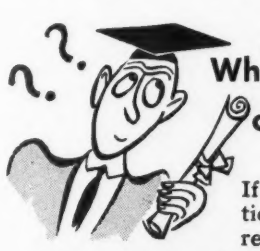
1. **WHAT IS THE TOTAL WEIGHT** of the electrons flowing through a 100-watt lamp filament, burning continually for one year on a 115-volt circuit—(a) 150-billionth ounce, (b) 5460-millionth ounce, (c) 2⅜ ounces?

2. **WHAT IS THE AMPERAGE** of the average thunderbolt—(a) 20,000 amperes, (b) 1,700,000 amperes, (c) 4,000,000 amperes?



3. **AIR PASSING THROUGH** the experimental wind tunnel at Wright Field, during a single hour, weighs as much as—(a) Army "jeep", (b) electric locomotive, (c) medium-size ocean liner?

4. **THE PUREST FORM** of iron ever produced is used in—(a) arc-welding electrodes, (b) thermostatic controls, (c) spectrum analysis?



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Write: The District Educational Coordinator, Westinghouse Electric Corporation, 10 High Street, Boston 10, Massachusetts.

ANSWERS

1 — *(b) Six million trillion electrons flow through a 100-watt filament every second at 115 volts — 17.1×10^{25} electrons per year — weighing about .005 ounce.*

2 — *(a) The intensity and duration of lightning strokes are measured and recorded automatically by the "fulchronograph" — developed by Westinghouse engineers.*

3 — *(c) Every hour, about 27,000 tons of air are driven through the Wright Field wind tunnel by a 40,000 hp electric motor — designed and built by Westinghouse engineers.*

4 — *(c) Iron 99.99% pure, is essential for comparison purposes in spectrography. It is produced in the Westinghouse Research Laboratories by fusing the purest commercial iron obtainable in a high frequency induction furnace, surrounded by an atmosphere of hydrogen gas.*

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When metal first went through the mill

The first rolling mill in this country was on the Chester Creek in the Colony of Pennsylvania. It was built in 1746 by John Taylor, the descendant of an English settler, for his "Sarum Ironworks." The plant had "three stacks" and worked at "full blast," turning out iron bars which were hauled to Marcus Hook for shipping.

Today not only rolling mills but ingot cars, cranes and all the heavy machines used in the steel industry are equipped with anti-friction bearings, many of which are furnished by SKF. For SKF Bearings support tremendous loads and their built-in alignment compensates for shaft deflections.

Since SKF makes so many kinds of ball and roller bearings, an SKF engineer can give you expert help in selecting

THE RIGHT BEARING FOR THE RIGHT PLACE

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SKF
BALL AND ROLLER
BEARINGS

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Kodak

Photomicrograph of a snowflake

Because photography magnifies . . .

Before this young girl could examine this snowflake, photography had to do a twofold job. It had to record the snowflake...quickly, exactly...before it melted. It had to enlarge this image 360 times . . . so that every detail would stand out clearly and sharply.

A unique ability . . . this. And because of it, business and industry have come to depend more and more upon photography to make the transient lasting . . . the invisible visible. They depend upon . . .

Document copying . . . to make big, accurate "blow-ups" of records, drawings, layouts.

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Microradiography . . . to probe the third dimension by magnifying microstructures in depth.

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For an introduction to applications that bring you the benefits of this unique ability, write for free booklet —"Functional Photography."

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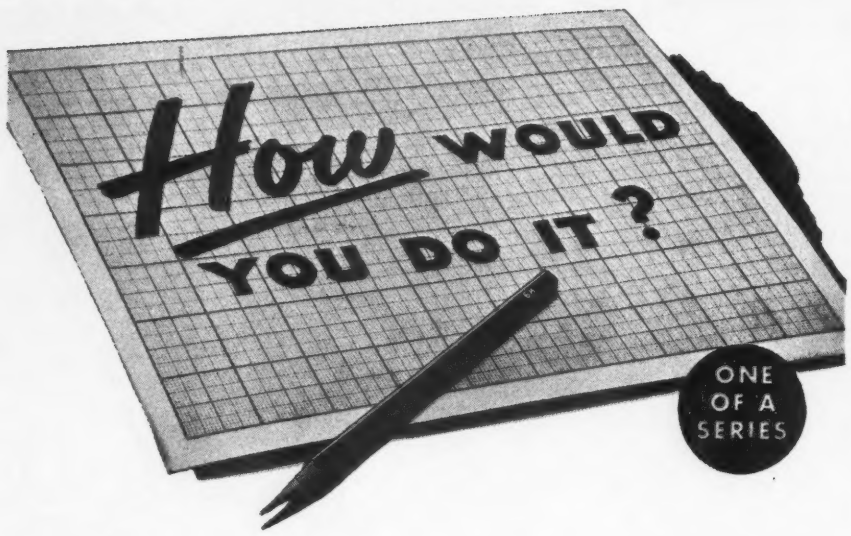


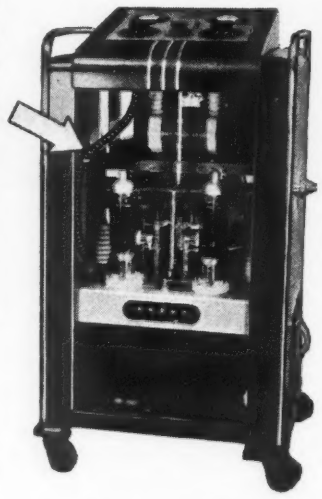
PROBLEM — You are designing a diathermy unit. Included in the electrical circuit are variable elements which must be adjusted during operation. The control knobs must be located where they will be convenient to the operator. The variable elements themselves must be located in the cabinet where they will be easy to mount, to wire and to service. How would you do it?

THE SIMPLE ANSWER

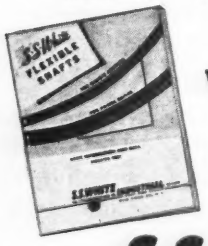
Use an S.S.White remote control type flexible shaft to couple each variable element to its control knob. This simple arrangement makes it possible to place the elements and their controls anywhere you want them. And you will find, too, that operation with these shafts is as smooth and sensitive as a direct connection, because S.S.White remote control flexible shafts are designed and built especially for this type of duty.

★ ★

This is just one of hundreds of remote control and power drive problems to which S.S.White flexible shafts provide a simple answer. That's why every engineer should be familiar with the range and scope of these "Metal Muscles"* for mechanical bodies.



Here's how one well known electronic equipment manufacturer did it. The flexible shaft (arrow) connects control knob at top to a variable element at the bottom rear.



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One of America's AAAA Industrial Enterprises

PHILIPPINE ISLANDS

(*Continued from page 105*)

worked. During the war the shafts were almost all destroyed but the gold is still there. The exploration has already been done, they know where the gold is; all there is to do now is mine it. Copper is also found in the region and it was beginning to be mined before the war. The ore is rich and extensive. Copper exports were valued at $641,650 in 1938. Chromium, lead, iron, and manganese also abound and await development. The exports of iron ore amounted in 1938 to $2,040,322. As yet, the iron has only been exported as ore and no refining facilities are in existence in the Philippines.

The soil of the Philippines is rich and produces a number of commercial crops. The greatest export crop of the islands is sugar. Most of the sugar was exported raw, but a short time before the war several alcohol distilleries were set up. With the granting of independence the preferential place of Philippine sugar in the American market will cease. This will force sugar interests to increase their efficiency, especially through the utilization of by-products. This may mean the development of chemical industries based on what can be made from sugar and its derivatives.

The Philippines ranked second in the world production of coconut. Recent experiments have brought a great many uses for coconut products, as they can serve as the basis for a great number of organic chemicals. So far the coconut has been exported as dried meat, called copra, but the development of local industries using this product is but a question of time.

Ever since the days of the clipper ships, rope made from Philippine hemp has been famous the world over. It is produced from the fibers of the abaca plant, grown extensively in the Islands. Tobacco is also produced in quantity, and wartime shortages have shown that good cigarettes can be made from it. Besides these, the other crops of economic importance are rice and corn, but these are grown for local consumption.

The forests in the Philippines abound with lumber, and the Philippine hardwoods are also widely known. The estimated investment was $15,500,000 in 1937, and about 77 per cent was locally consumed. The planting of rubber-bearing trees has been tried in Mindanao

(*Continued on page 128*)

RCA Victor "Eye Witness" television receiver shown above, gives you 52 square inches of picture brilliance.

A referee's eye view of every play – by Television!

You feel as though you were right there at the game—when you see it through RCA's brilliant television.

Football fans as far as 250 miles away from the stadium have enjoyed watching many of the big games this fall through NBC telecasts. And football fans become television fans when they see how closely the camera follows the ball.

At the game, the sensitive RCA Image Orthicon television camera sees every line plunge, kick, pass and run. It may be a cloudy day or the sun may go down but you still enjoy the *bright sharpness* of the RCA Image Orthicon camera.

On the screen of your RCA Victor home television receiver none of that bright sharpness is lost.

For after you've tuned in the game, the new RCA Victor "Eye Witness" Picture Synchronizer automatically "locks" the picture in tune with the sending station—eliminates any distortion—assures you of *clearer, steadier* pictures.

For television at its best, as pioneered at RCA Laboratories, you'll want the receiver that features the most famous name in television today—RCA Victor.

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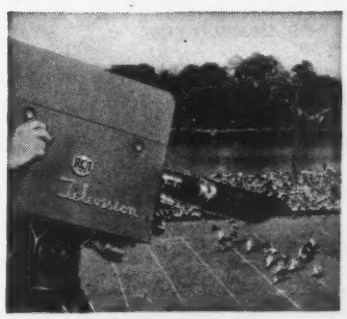
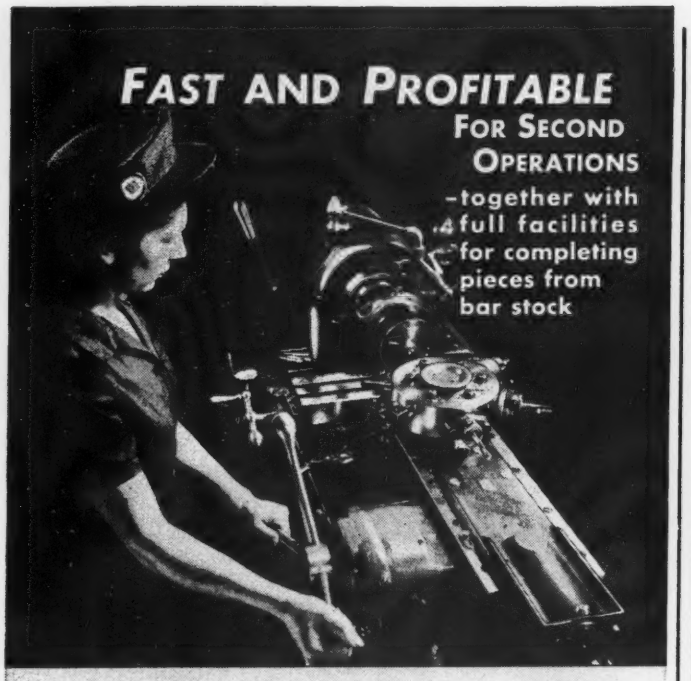
Radio Corporation of America, RCA Building, Radio City, New York 20, N. Y.



RCA Image Orthicon television camera—developed at RCA Laboratories—makes close-ups out of long shots. It enables television to go anywhere by freeing it from the need for strong lights or sunshine.

RADIO CORPORATION of AMERICA



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Answers to last month's:

Can You Do It?

1. This problem can be solved by simple algebra, in spite of seemingly impossible conditions. If we let

x = the man's speed,
y = the speed of the escalator, and
n = the number of steps on the escalator when at rest,

then, in each case

$$\frac{\text{the man's speed}}{\text{his total velocity}} \text{ equals } \frac{\text{the number of steps he touches}}{\text{the total number of steps}}$$

or,

$$\frac{x}{y+x} = \frac{50}{n} \quad \text{and} \quad \frac{3x}{y+3x} = \frac{75}{n}.$$

Solving for $y+x$:

$$\frac{3nx}{75} - 2x = x + y = \frac{nx}{50}.$$

It will be seen that the "x" drops out, leaving a simple equation containing only the unknown "n" which turns out to equal 100. You have solved two equations containing three unknowns! (Actually, "x" and "y" cannot be found, even though "n" can!)

* * * *

2. There is no strictly mathematical way to solve this problem. However, by keeping in mind the following conditions, several solutions can be figured out.

A. By conditions, every man will be chained to every other man.
B. No man must be in the center more than twice.
C. No combination of two men must be in the center more than once.

If the original set-up is:
1 — 2 — 3
4 — 5 — 6
7 — 8 — 9
then one possible solution to the other five arrangements is as follows:

5 — 1 — 6	1 — 3 — 8	7 — 1 — 9	1 — 4 — 7	2 — 7 — 5
4 — 2 — 8,	4 — 6 — 7,	5 — 2 — 8,	3 — 5 — 8, and	1 — 8 — 6.
3 — 7 — 9	2 — 9 — 5	6 — 3 — 4	2 — 6 — 9	3 — 9 — 4

J. W. W.

"Wisdom must be intuitive reason combined with scientific knowledge"

—ARISTOTLE (DIALOGUES)

·Why some things get better all the time

THE TEMPTING FOODS spread before the family of today are more nourishing and purer than ever before.

All the way from farm to table, *modern means of food preservation* protect foods against damaging molds, bacteria, insects—against loss of nutrients.

Chemical refrigerants preserve meat . . . nitrogen gas safeguards the purity of canned foods . . . ethylene oxide and "dry ice" protect wheat before it is milled . . . stainless steel tanks prevent contamination of foods and beverages . . . and plastics line many food containers.

Food preservation has become an industrial science —and well illustrates the fact that when man has better materials he can do better things.

Producing better materials for the use of industry and the benefit of mankind is the work of UNION CARBIDE.

Basic knowledge and persistent research are required, particularly in the fields of science and engineering. Working with extremes of heat and cold, and with vacuums and great pressures, Units of UCC now separate or combine nearly one-half of the many elements of the earth.

UNION CARBIDE
AND CARBON CORPORATION

UCC

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Products of Divisions and Units include—

ALLOYS AND METALS • CHEMICALS • PLASTICS
ELECTRODES, CARBONS, AND BATTERIES
INDUSTRIAL GASES AND CARBIDE

THAT'S NO TRICK AT ALL. IT'S ROEBLING WIRE ROPE. IT ALWAYS STANDS UP!
AND THAT GOES FOR THEIR ELECTRICAL WIRES AND CABLES, WOVEN WIRE, ROUND, FLAT AND SHAPED WIRE, AND STRIP STEEL TOO!
MACK HARROW

Roebling produces every major type of wire and wire product . . . toaster cord to telephone cable . . . bridge cable to wire rope . . . fine filter cloth to heavy grading screen . . . strip steel and flat wire to round and shaped wire . . . all Roebling products. *All* the result of over 100 years of wire specialization.
John A. Roebling's Sons Company, Trenton 2, N.J.

JR ROEBLING

ROEBLING

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WIRE ROPE AND STRAND • FITTINGS • SLINGS • AIRCOIL, AIRCORD TERMINALS AND AIR CONTROLS SUSPENSION BRIDGES AND CABLES • AERIAL WIRE ROPE SYSTEMS • SKI LIFTS • ELECTRICAL WIRE AND CABLE • HARD, ANNEALED OR TEMPERED HIGH AND LOW CARBON FINE AND SPECIALTY WIRE, FLAT WIRE, COLD ROLLED STRIP AND COLD ROLLED SPRING STEEL • LAWN MOWERS SCREEN, HARDWARE AND INDUSTRIAL WIRE CLOTH

PHILIPPINE ISLANDS

(*Continued from page 124*)

and it seems possible that they can be grown for commercial purposes. During the occupation, the Japanese attempted to grow cotton in the plains of Luzon. How successful they were is not known, but there might well be surprising possibilities.

Harbor facilities in the Islands are excellent and extensive. Many good natural harbors have been developed and the American military engineers have done a wonderful job of rebuilding them. The American regime has also done an incomparable job in building roads and other means of communications. Manila was connected by steamship with the principal countries of the world, and airlines have been established bringing the Philippines closer to the industrial centers of the world.

As yet, no extensive coal or petroleum deposits have been developed. These have been found in different parts of the country but their extent and value are not as yet known. But the proximity to the great oil-fields of the East Indies could make fuel oil available at low cost. Water power is found in every one of the large islands. A large hydroelectric plant was being built before the war which would provide Manila with cheap electric power. The possibilities of these sources of power are very great.

Though not myself a Filipino, I have lived with them for a long time, studied with them, worked with them, and fought with them. They know their potentialities and are willing to do their utmost for their country and the world. They are a people with a great future.

There are a number of very good engineering schools in the Philippines, and a large number of men are being trained in technical lines, but the demand is far beyond the supply. The Filipino people are rebuilding their country and doing a good job of it. They are working hard, but they need outside help in brains and in money. But the risk for such outside investors is small indeed, for the Philippines are sure of a brilliant future.

Figures are quoted from the booklet "Facts and Figures About the Philippines," published by the Information Division, Office of the Resident Commissioner of the Philippines, Washington, D. C., 1942. The 1938 statistics are the most reliable since they show figures unaffected by the necessities of war. War has been going on in the Far East since 1937.

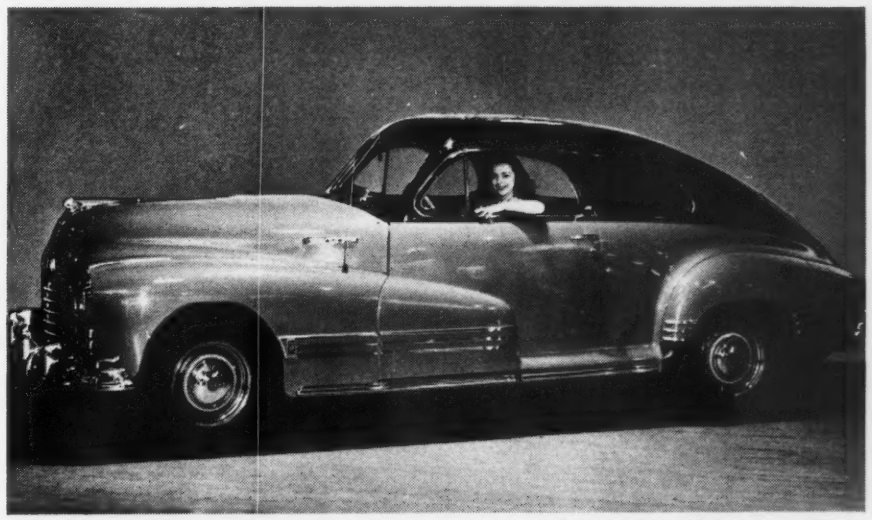
Du Pont *Digest*

Items of Interest to Students of Chemistry, Engineering, Physics, and Biology

Chemistry Provides New Colors for New Cars

In Detroit this spring, automotive engineers and designers were shown a dozen cars finished in glowing colors never before seen on any automobile—colors that diffused and reflected light back to the eye from within the finish instead of from the surface.

These new "Duco" Metalli-Chrome lacquers which attracted industry-wide attention are expected to give new beauty and durability to America's cars. The story behind their development is an interesting one.



New Techniques for Pigment Preparation

As many commercial pigments are now made, they are precipitated from chemical solutions in the form of fine particles, which are then dried, ground and reground with a liquid vehicle to produce the final paint, enamel or lacquer. The fineness of the particle-size largely determines the luster of the finish. Although mechanically ground pigment particles can be made extremely fine, they are not nearly as small as the particles originally precipitated.

A few years ago a program of research was started by Du Pont scientists to try to take advantage of the very fine particles formed by precipitation. They proposed to eliminate the drying and grinding processes entirely—to transfer the microscopically sized, precipitated, hydrated pigment particles directly from the mother solution to the lacquer vehicle.

Extended study by organic and colloid chemists, physicists and chemical engineers finally solved this problem. The procedure consists of mixing the wet pigment in a heavy-duty mill with water-wet nitrocellulose, dibutyl phthalate and castor oil. Dibutyl phthalate forms a colloidal solution with nitrocellulose. The colloid absorbs the castor oil and pigment, but eliminates the major portion of the water as a separate insoluble phase.

A New Range of Color Effects

After the method of transferring wet pigment particles had been established, the second development in this program was the practical utilization of precipitated ferric hydroxide. Although it had been used for a long time as an intermediate for the manufacture of dry ferric oxide pigment, ferric hydroxide in the wet form as a pigment had been applied only to a very limited extent and its true value had gone unrecognized. When used in conjunction with the new process, wet ferric hydroxide produced a lacquer of unusual brilliance and durability. In combination with other pigments, a whole new range of color effects became possible.

Because of their extremely small pigment particle-size, the Metalli-Chromes are somewhat translucent, having a distinctive, soft innerglow. This lustrous depth is further enhanced by introducing into the film aluminum particles which act like mirrors to reflect the light within the finish.

Not only are these new lacquer finishes more lustrous and more beautiful, but they are also more durable, as proved by four years of laboratory and road-testing. "Duco" Metalli-Chrome lacquer is a worthy newcomer to the ever-lengthening list of developments by men of Du Pont that have helped in the mass-production of automobiles and the creation of new industries, new markets, new jobs for millions of Americans.

Questions College Men ask about working with Du Pont

WILL I FIND COMPETITION DIFFICULT AT DU PONT?

It is to be expected that there will be competition in an organization where every effort is made to select the best trained and most promising graduates. However, such competition is not deliberate or is it on an elimination basis. New employees are given every opportunity to grow in the organization.

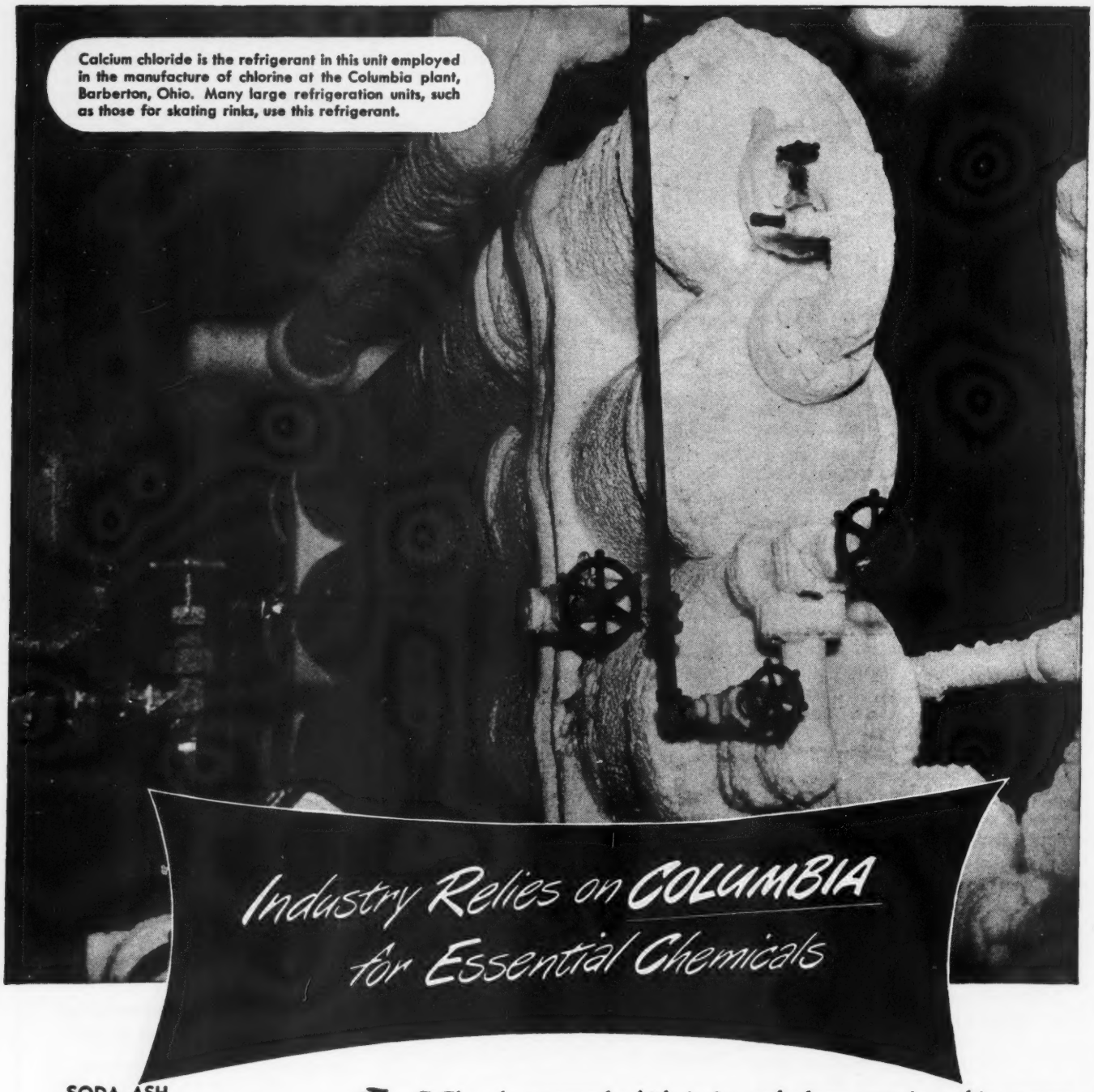
Technical undergraduates and graduate students will be interested in the new booklet, "The Du Pont Company and the College Graduate." Write to 2521 Nemours Building, Wilmington, Del.

DU PONT
REG. U. S. PAT. OFF.

BETTER THINGS FOR BETTER LIVING
...*THROUGH CHEMISTRY*

E. I. DU PONT DE NEMOURS & CO. (INC.)
WILMINGTON 98, DELAWARE

More facts about Du Pont—Listen to "Cavalcade of America," Mondays, 8 P.M. EST, on NBC


Calcium chloride is the refrigerant in this unit employed in the manufacture of chlorine at the Columbia plant, Barberton, Ohio. Many large refrigeration units, such as those for skating rinks, use this refrigerant.
Industry Relies on COLUMBIA for Essential Chemicals

SODA ASH
CAUSTIC SODA
LIQUID CHLORINE
CALCIUM CHLORIDE
SODIUM BICARBONATE
MODIFIED SODAS
CAUSTIC ASH
PHOSFLAKE *(bottle washer)*
SODA BRIQUETTES *(iron desulphurizer)*
CALCENE T *(precipitated calcium carbonate)*
SILENE EF *(hydrated calcium silicate)*
PITTCHLOR *(calcium hypochlorite)*

$CaCl_2$—A compound which in its annhydrous state is a white, porous, solid of such high hygroscopicity that 1 pound absorbs 8.4 pounds of water (77°F.—humidity 95). Occurring as a by-product in many chemical manufacturing processes, calcium chloride was considered for many years as a hard-to-dispose-of waste material until research led to its use in varied fields.

Today, calcium chloride finds many uses in refrigeration, roadbed conditioning, road-surface ice and dust control, coal and coke treating, and concrete curing.

COLUMBIA CHEMICALS

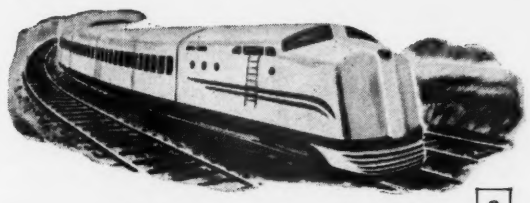
PITTSBURGH PLATE GLASS COMPANY • COLUMBIA CHEMICAL DIVISION
FIFTH AVENUE at BELLEFIELD • PITTSBURGH 13, PENNSYLVANIA

Chicago • Boston • St. Louis • Pittsburgh • New York • Cincinnati • Cleveland • Philadelphia • Minneapolis • Charlotte • San Francisco

You saw us today . . . remember?

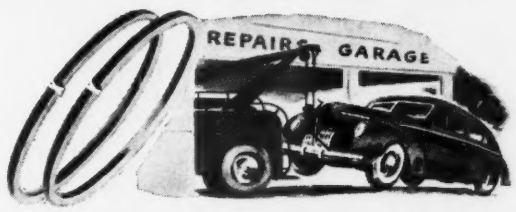
When you crossed the road [1]

and saw that orchard . . . [2]



or watched the train . . . [3]

or bought a new dress . . . [4]

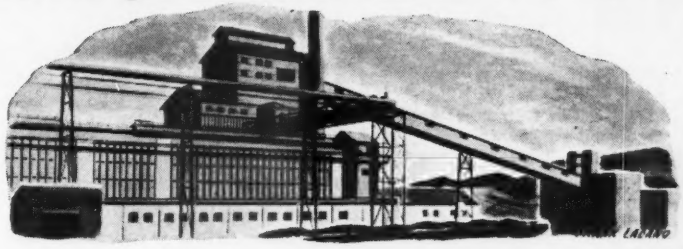


left your car for repair . . . [5]

or ordered roofing . . . [6]

or took your vitamins . . . [7]

or made a phone call . . . [8]



you saw a Koppers product in use [9]

K
KOPPERS

1. Tarmac. **2.** Flotation Sulfur Sprays. **3.** Pressure-treated cross ties. **4.** Chemicals for dye intermediates. **5.** Piston rings. **6.** Roofing. **7.** Chemicals for pharmaceuticals. **8.** Chemicals for molded plastics. **9.** Coke plants. All these are Koppers products . . . and many others that touch your welfare in countless ways. The Koppers trademark is the symbol of a many-sided service. Wherever you see it, it means top-notch quality. Koppers Co., Inc., Pittsburgh 19, Pa.

FRICK

Refrigeration

Performs many vital services in the production of pharmaceuticals and biologicals for Sharp & Dohme of Philadelphia.

This 100-year-old firm uses Frick refrigeration to condition air, condense alcohol, solidify wax, harden gelatin, and cool drinking water. Also in the production of insulin, and for maintaining even temperatures in vaults where enormous quantities of biologicals are stored. Frick equipment has given dependable service to Sharp and Dohme for over 15 years.

The Frick Graduate Training Course in Refrigeration and Air Conditioners, now in its 30th year, is approved under the G.I. Bill of Rights.

FRICK COMPANY, Waynesboro, Pennsylvania

LOOK TO NE

. . . . . to meet today's electrical requirements and those of tomorrow

SINCE 1905

A symbol of quality on wiring systems and fittings for every conceivable requirement.

National Electric
PRODUCTS CORPORATION
Box 897 — Pittsburgh 30, Pa.

WARTIME DEVELOPMENTS

(*Continued from page 100*)

electronic circuit and transmitting the actual shape of the letters instead of electrical impulses, is simple, rugged and able to send ungarbled messages over long and poorly constructed circuits. Interference which would cause an American machine to print wrong letters merely distorts the shape of the letters sent by the German machine.

Other interesting electronic devices produced by the Germans include an electronic ignition system for aircraft and a new type of cathode-ray tube which permits an oscillogram to be retained indefinitely or to be erased rapidly at will. The tube was used in search radar and in sonic direction-finding equipment.

In several respects, German industry lagged behind American industry, due in part to the emigration of the many German scientists who opposed Nazi policies, and in part, apparently, to the plentiful supply of low-cost labor in prewar Germany which made many technical improvements uneconomical. The Germans were particularly backward in the air-conditioning and refrigeration industry, in the use of automatic controls for measuring temperature, pressure, humidity, and other factors, and in the manufacture of small metal objects such as safety pins and snap fasteners. Much of the German success on the world markets before the war was due to inferior working conditions, export subsidies, and the use of low-paid and prison labor.

THE CHRISTMAS STAR

(*Continued from page 101*)

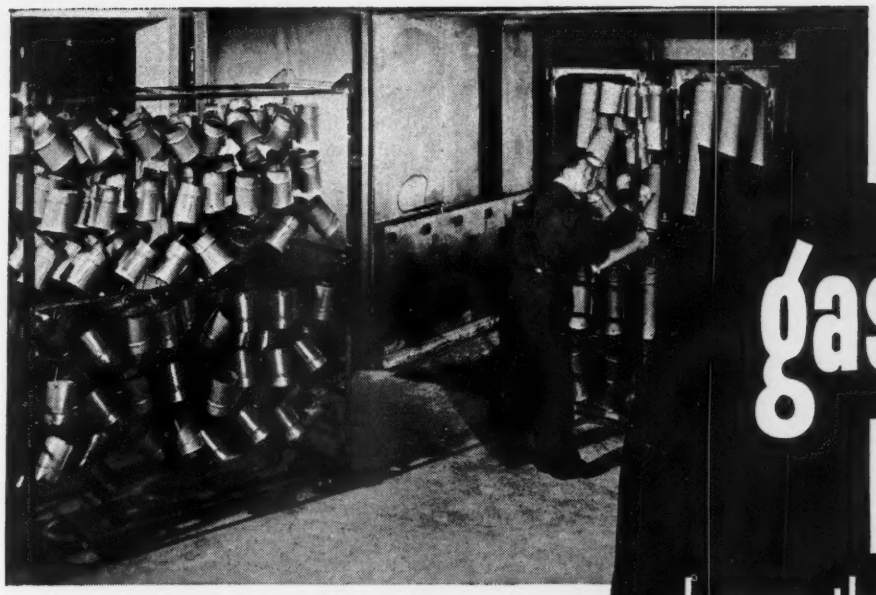
not known. The most widely accepted date is that indicated by the historian Josephus, who noted a lunar eclipse on the death of Herod, in whose reign Christ was said to have lived. Calculations show that there was an eclipse of the moon on March 13, 4 B.C., the year of Herod's death. Since the Magi were known to be scholars, men who would have been familiar with the night sky, it is safe to assume that whatever the star was, it was something far out of the ordinary. Let us examine some of the possibilities.

Supernova: These are normally faint stars, that occasionally flare up to many times their original brilliance, often surpassing every other object in the night sky. However, there is no record of a supernova around this time, and if one had occurred, it would certainly have been recorded.

Meteors: These are the shooting stars that enter our atmosphere and flare up with an intense white heat. Since they last only a few seconds, and the Star was said to have remained in the heavens for many days, this possibility is doubtful.

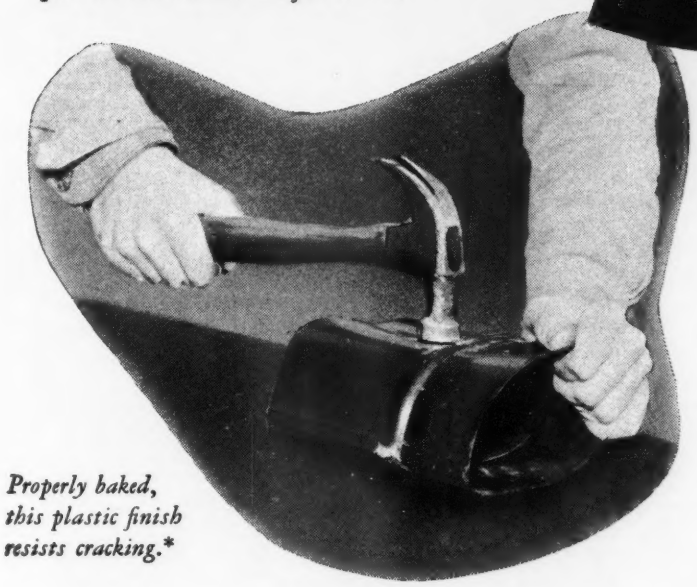
Comets: Comets are the lonely voyagers in space whose appearances have often been interpreted as omens and portents, associated with both good and evil. A comet is sometimes visible for several weeks or months, and a conspicuous tail might well appear to be leading to some far-off place beyond the horizon. It is an interesting fact that the Chinese, the finest astronomers of ancient times, recorded a comet from February to April in 4 B.C.

Planetary Conjunction: In the fall of 1604, Kepler observed Jupiter, Saturn and Mars in close conjunction, forming a strange pattern in the sky. He calculated the frequency of such a triangular configuration, and found that it happens approximately every eight hundred years. Furthermore, he calculated a conjunction occurring in 6 and 7 B.C., in the constellation of Pisces, a constellation sacred to the Jews. If God had wished to send a sign, what better place in the sky was there?



*Gas-fired polymerizing oven being charged with plastic-coated aluminum flue liners.**

gas and plastics change the face of things



*Properly baked, this plastic finish resists cracking.**

Plastic coating of metal parts expands the whole field of applications for both metals and plastics. By varying the chemical composition of the plastic an infinite variety of new surfaces can be created for metals.

An essential element in the perfect union of metal and plastic is heat—clean, dependable, accurately-controlled heat—the kind obtained with modern Gas-fired ovens.

Experienced producers of plastic-coated metals, such as Heremetal Company, Minneapolis, Minnesota, use GAS for polymerization ovens because GAS insures the uniform heat, rapid response to heat control, and exact temperatures so essential to processing.

Where there's a difficult industrial heating problem there's a job for GAS. In the fields of plastics, metallurgy, chemistry, electronics, the productive flames of GAS provide the most flexible, dependable heat source for pioneering or productioneering.

**Photos courtesy of Despatch Oven Co., Minneapolis, Minn.*

MORE AND MORE...

THE TREND IS TO GAS

FOR ALL INDUSTRIAL HEATING

AMERICAN GAS ASSOCIATION

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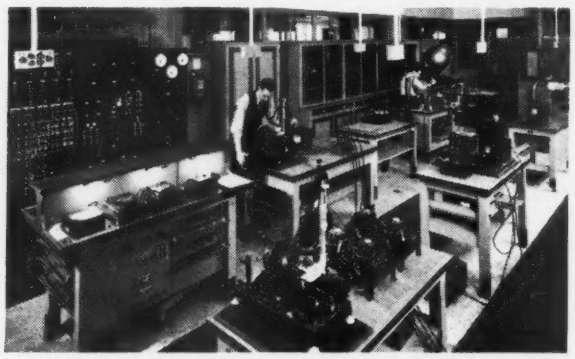
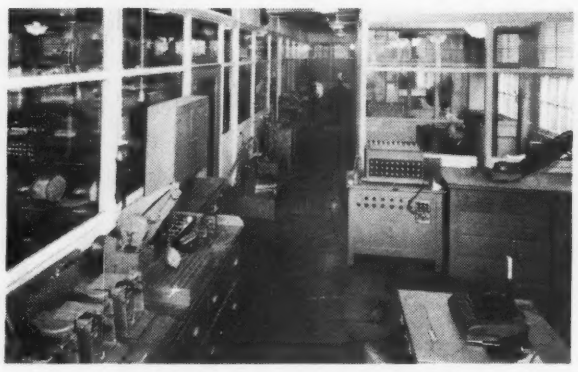
Laboratory Facilities

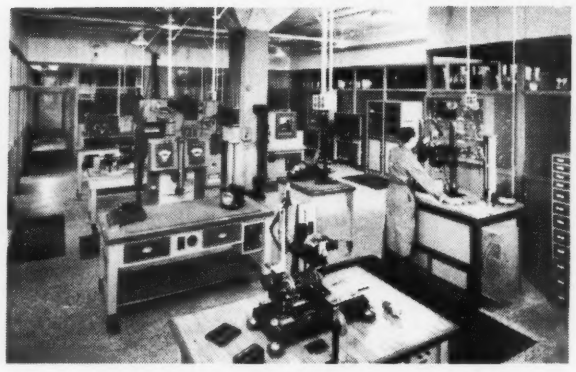
HOOVER ENGINEERING DEPARTMENT



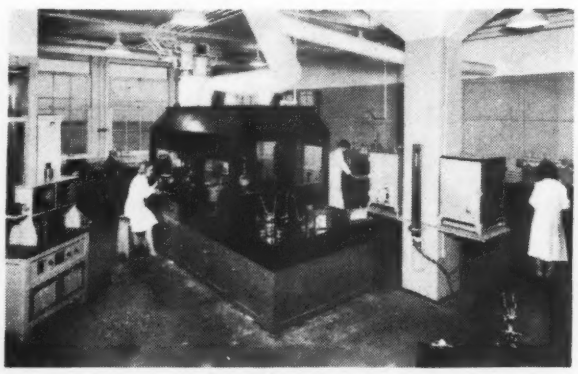
The Electrical Laboratory designs, tests and redesigns motors and component parts in developing power plants for Hoover Cleaners.



The Testing Laboratory maintains production control by acceptance tests on parts and materials. Test specifications and special test apparatus are developed here.



Filters, fans, materials, processes are tested in the Mechanical Laboratory; air flow and power problems, cleaners and cleaning methods are studied.



In this modern, fully equipped laboratory exhaustive chemical and metallurgical tests are conducted on metal, fabric, wood, paper and plastics.

A 50-ton room supported on numerous steel springs affords perfect acoustical isolation, insuring precision measurement on noise and vibration problems.

Building the world's largest-selling electric cleaner is big-time engineering, and many thousands of hours of design, tests, research and study go into constructing each new cleaner model.

The Hoover Engineering Department is recognized as a leader. Hoover engineering problems call for the full range of engineering skills—and the best in both equipment and personnel is necessary to handle them.

THE Hoover COMPANY North Canton Ohio

Wood specimens which show the excellent preservative qualities of Pentachlorphenol. The two pieces on the right were impregnated with this protection against decay. All four pieces were buried underground for six years in a Dow test plot.

Chemistry gives lumber longer life . . .

Growing trees can fight their own battles against many common destructive forces. Nature has seen to that. But power poles, fence posts and structural lumber are dead wood and suffer greatly from insect attack and the conditions that create decay. Here's where the chemist steps in and takes over nature's job to give lumber longer life.

During the past decade, notable progress has been made in developing preservative treatments for the protection of wood. Studies undertaken by Dow technicians have resulted in a new preservative known as Pentachlorphenol which is being used successfully without the attendant disadvantages of the older commonly used materials. Pentachlorphenol gives every assurance of greatly extending the useful life of lumber.

Development of chemicals for treating lumber is only one phase of the work that is constantly underway at Dow. Our interests range from ultra-light magnesium to chemicals that promote the health of the Nation and the progress of every industry.

The scientific mind and the scientific method are of first importance to Dow.

THE DOW CHEMICAL COMPANY, MIDLAND, MICHIGAN

New York • Boston • Philadelphia • Washington • Cleveland • Detroit
Chicago • St. Louis • Houston • San Francisco • Los Angeles • Seattle

It's a long step (and a long wait) between a brilliant idea and a salable product. Can this expensive time lag be reduced? Yes . . . by "Mass Precision" methods!

What is "Mass Precision"? It's engineering know-how, plus research, plus modern machines in the hands of skilled workmen, plus the finest gaging equipment. It's a method that Nichols has developed and refined for over 40 years. It's a method that quickly translates good ideas into simple, highly accurate products that can be mass produced, *on a strictly interchangeable basis,* at low cost.

Our new booklet "Mass Precision" shows what we've done for others . . . perhaps it will suggest what we can do for you. Write for your copy today.

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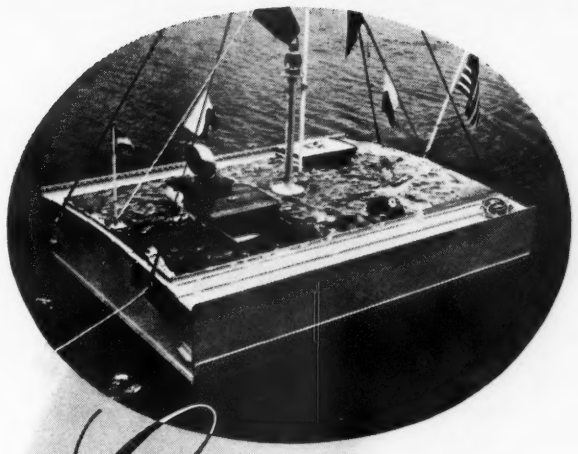


Cinderella

TAKES A CHINESE HONEYMOON

• The Cinderella of Chesapeake Bay is a queer looking craft. She has no bow, no stern, no engine, no crew. Never weighs anchor to make a voyage. But she *has* a purpose, and has served it well.

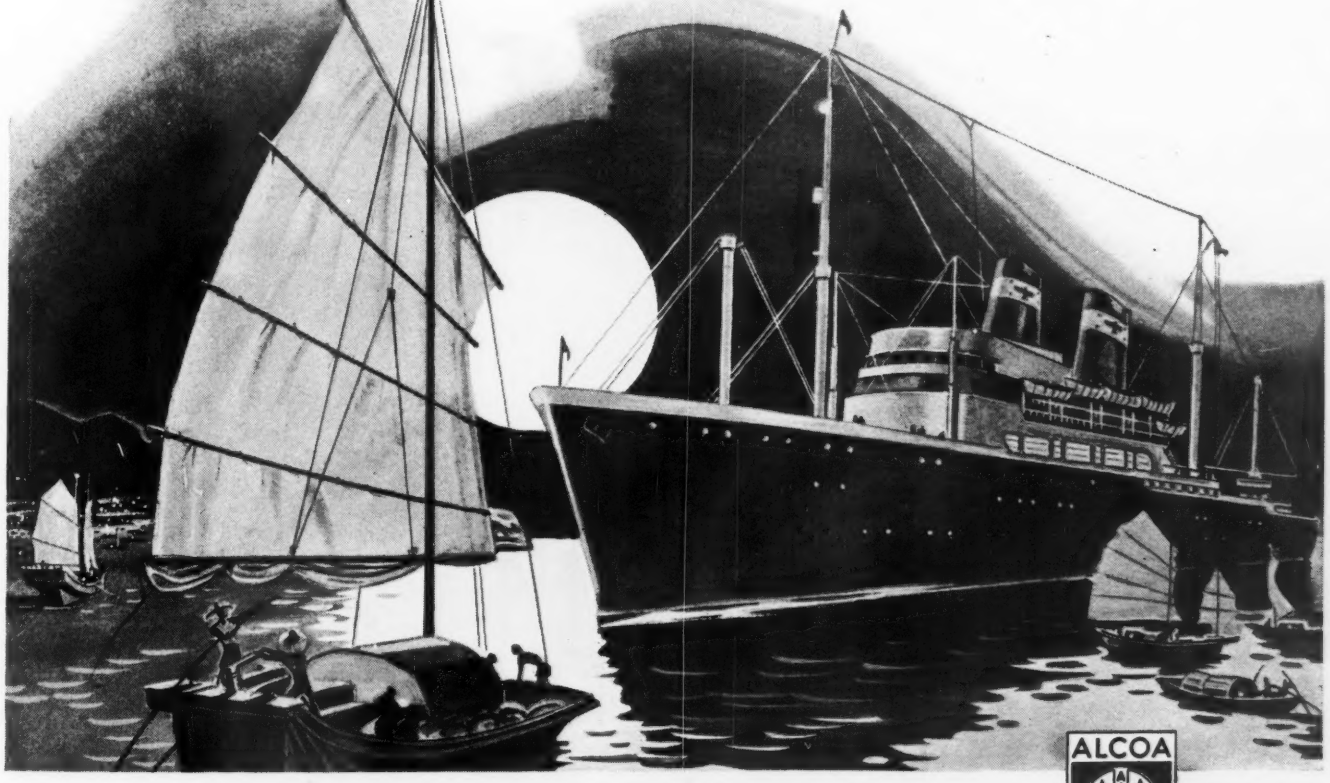
Largely because of her, a new fleet of ocean-going passenger ships will have superstructures built of *aluminum.* It reduces weight at the most important place—"topside".

This is a dream come true for Alcoa engineers. Eleven years ago they built this odd-shaped aluminum test hull and anchored it in Chesapeake Bay. Together with marine engineers and naval architects, they watched to see the effect salt water had on aluminum; whether it would prove seaworthy. And it did!

But there were other problems—for instance, stresses topside, set up by the weaving and pounding that a ship takes at sea. By building and testing a model, Alcoa engineers found that the use of aluminum in the superstructure greatly reduced the stresses. They likewise conferred on plans and recommended materials.

So the ships were built. They are in the water now being outfitted for their maiden voyages to China—thanks to Cinderella and the "imagineers" who dreamed of aluminum ships and then engineered them into the water.

Doesn't a company that pursues an ideal with such intensity stir your imagination? It's fun to work with men of vision. Ideas click when men with imagination plus engineering work with this versatile metal, aluminum, and with the greatest fund of aluminum knowledge in the world . . . Alcoa's. ALUMINUM COMPANY OF AMERICA, Gulf Building, Pittsburgh 19, Pennsylvania.



ALCOA FIRST IN **ALUMINUM**

CORNELL UNIVERSITY

. . . a great name in research with a big future in CHEMISTRY

PLASTICS . . . SOLVING AN ELECTRICAL PROBLEM BUILT AN INDUSTRY

Electrical necessity was one of the mothers of plastics invention. The necessity was to insulate electric power so that it could be put to work when needed.

General Electric's plastics story began back in 1894. A molding process acquired from a lead pencil manufacturer was used by the 3-year-old company to make arc lamp carbons out of lampblack-impregnated potter's clay—an ancient plastic.

Before the turn of the century, General Electric found more and more uses for the process—molding rubber, shellac, copal and other natural resins into insulating parts for apparatus. But it was evident that G-E Research would have to find better, more dependable, more moldable materials with which to insulate the complex apparatus and appliances envisioned.

Chemistry Solves the Problem

When needed most by the infant electrical industry, chemistry synthesized phenolic resin and brought it to commercial production. By 1912 General Electric was molding this new synthetic into stronger, better-looking insulating parts with electrical properties which chemistry brought under accurate control.

Chemistry, of course, became an increasingly important phase of G-E Research. New synthetics and new polymers of interest to the whole field of chemistry began coming from General Electric Laboratories.

G-E Chemistry Helps Build the Plastics Industry

Phenolic molding and laminating were expanded rapidly to satisfy General Electric's own increasing needs. Soon it became possible to accommodate more and more outside customers who were drawn by the development of G-E techniques in handling new materials. Plastics, as they came to be called, were becoming one of chemistry's important contributions to industry. Plastics parts, which could be molded in a single operation, were destined to save millions of man-hours of machining and to make thousands of products more attractive, safer, and easier to use.

By 1940, General Electric occupied a unique position in the plastics field. It was the only unit engaged in the three principal divisions of the plastics industry—raw material manufacture, molding, and laminating. General Electric became the world's largest manufacturer of finished plastics products.

Tremendous Trifles for War Production

This position was consolidated during the war. General Electric was called upon to produce more than 14,000 different plastics products—a large part of them being technical items of the greatest precision—all of them tremendous trifles vital to the production of all kinds of war equipment.

There was a great increase in General Electric's capacity to produce plastics products. Even more significant was the development of new manufacturing processes, new plastics materials, and new concepts of the usefulness of plastics in the world.

To coordinate expansion not only in plastics, but in other chemical fields, the Chemical Department of General Electric has now been established as a separate organization within the Company. A great new name in chemistry, The Chemical Department of General Electric has its own laboratories . . . administers eight factories of the G-E Plastics Divisions and G-E Resin & Insulation Materials Division . . . and is building new chemical laboratories and plants—one for the commercial production of silicones. The Chemical Department, General Electric Co., 1 Plastics Avenue, Pittsfield, Mass.

A message to students of chemistry and chemical engineering from

DR. C. G. SUITS

Vice President and Director, G-E Research Laboratory.

An essential ingredient of G-E Research is the fresh viewpoint of young chemists and chemical engineers. That is the reason why they are always welcome—more of them every year—to work with us to solve the many problems of our expansion in chemistry.

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